DEPARTMENT OF THE INTERIOR,

CENSUS OFFICE.

FRANCIS A. WALKER, Superintendent,
Appointed April 1, 1879; resigned November 3, 1881.

CHAS. W. SEATON, Superintendent,
Appointed November 4, 1881. Office of Superintendent abolished March 3, 1885.

REPORT

ON THE

MINING INDUSTRIES OF THE UNITED STATES

(EXCLUSIVE OF THE PRECIOUS METALS),

WITH SPECIAL INVESTIGATIONS

INTO THE

IRON RESOURCES OF THE REPUBLIC

AND INTO THE

CRETACEOUS COALS OF THE NORTHWEST.

BY

RAPHAEL PUMPELLY,
SPECIAL AGENT.

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, July 13, 1886.

Hon. L. Q. C. LAMAR,
Secretary of the Interior.

SIR: I have the honor to transmit herewith the report on the mining industries of the United States (exclusive of the precious metals) by Professor Raphael Pumpelly, of Newport, Rhode Island, chief special agent.

This report forms the fifteenth volume of the series constituting the final report on the Tenth Census.

I have the honor to be, very respectfully, your obedient servant,

JAMES H. WARDLE,
Chief of Census Division.

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Notes on the samples of iron ore collected in Virginia. By Edward R. Benton....261-288

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NOTES ON THE SAMPLES OF IRON ORE COLLECTED FOR ANALYSIS, ETC.—Continued.

Notes on the samples of iron ore collected in Virginia—Continued.

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Notes on the samples of iron ore collected in Kentucky. By W. M. Chauvenet 289–300

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Notes on samples of iron ore collected in North Carolina. By Bailey Willis 301–329

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Notes on the samples of iron ore collected in East Tennessee. By Bailey Willis 331–350

Iron-ore sample *map* of Tennessee and North Carolina (geologically colored) (Plate XXXV).

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NOTES ON THE SAMPLES OF IRON ORE COLLECTED FOR ANALYSIS, ETC.—Continued.

Notes on the samples of iron ore collected in East Tennessee—Continued.

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SPECULAR ORES.—Cannon bank (346 **d**); Maxwell bank (346 **e**); Cross Mountain bank (346 **e**); Stone Dye and Burke's banks (346 **f**); Smith's bank (347 **c**).

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Notes on the samples of iron ore collected in Tennessee. By W. M. Chauvenet 351–365

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LETTER OF TRANSMITTAL.

NEWPORT, R. I., *June* 15, 1884.

HON. CHAS. W. SEATON,

Superintendent of Census.

SIR: I have the honor to submit herewith the result of the statistical and special investigations into the mining industries of the United States (exclusive of the precious metals), with which I was charged.

I have the honor to be, sir, your obedient servant,

RAPHAEL PUMPELLY,

Special Agent.

INTRODUCTORY REMARKS.

In 1879 my division of the United States Geological Survey was detailed by Hon. Clarence King, the Director, to act as special agents of the Census Office. The work intrusted to me—collecting and discussing the statistics of the mining industries of the United States exclusive of the precious metals—promised to be one of unusual interest, and capable of being made of great benefit to the political economy of the country. The act authorizing the Tenth Census provided for special investigations separately of the great factors of the economy of the nation. It was essential to the success of the plan that the fundamental questions, about 30 in number, should be put in a strictly uniform manner, and that the answers should have as nearly as possible a uniform value. It was found to be impossible to accomplish this either through the regular enumerators of the Census Office or by correspondence c alone.

In the absence of even the most elementary list of establishments it became necessary, in order to obtain a complete representation, to have each district canvassed by special agents, who were generally more or less acquainted with the region and with the local mining industries. These personal interviews with the managers of the establishments, supplemented by correspondence from the central office, succeeded in obtaining a uniform result. Schedules of questions were prepared, under my direction, adapted to the various branches of mining and metallurgy, and containing a large number of questions capable of being understood by the mining community, and to most of which the answers could be summed up to totals for the whole country.

Although the questions asked varied according to the branch of the industry, the most important of those intended to foot with totals are contained in the following scheme: d

QUESTIONS OF LOCALITY.

State.
County.
Number of mines.

QUESTIONS RELATING TO PRODUCTION.

Maximum capacity of yearly product, in commercial units, of the substance mined.
Product during the census year, in tons, of the material hoisted.
Product during the census year, in the commercial units, of merchantable product.
Value of product.

QUESTIONS RELATING TO MATERIALS, LABOR AND POWER EXPENDED.

Value of materials or supplies used.
Wages.
Men employed above ground.
Men employed below ground.
Boys employed above ground.
Boys employed below ground.
Total employés.
Miners.
Laborers.
Administrative force.
Number of horses, mules, and oxen.
Number and horse-power of steam-engines.
Value of all machinery.
Value of explosives.
Cords of wood used for fuel.
Value of wood.
Timber (linear feet) used. e
Value of timber.
Sawed lumber (board measure) used.
Value of lumber.

QUESTIONS RELATING TO CAPITAL.

Amount of working capital.
Value of plant.
Value of real estate.
Total capital.

In additions to the above questions, to which answers were required from all establishments, there were asked a large number of other questions, the answers to which, from a considerable number of establishments, would f give the necessary data for estimating the totals for the whole industry.

The following gentlemen were appointed special agents of the census to collect these statistics: In the eastern district of Pennsylvania, Mr. Charles Allen, Harrisburg, Pennsylvania. In Huntington, Bedford, Clearfield, and Potter counties, Pennsylvania, Mr. C. B. Finley, Huntington, Pennsylvania. In Cambria, Blair, Indiana, and Somerset counties, Pennsylvania, Mr. Walter Fellows, Johnstown, Pennsylvania. In the western district of Pennsylvania—comprising the rest of the state—Mr. Edward B. Alsop, Pittsburgh, Pennsylvania. In Ohio, President Edward Orton, of the University of Ohio, Columbus, Ohio, assisted by Professors N. W. Lord and A. G. Wetherby, and Messrs. Andrew Roy, Edward Hyatt, and Edward Orton, jr., all of Columbus, Ohio. In northern Illinois and Iowa, Mr. W. L. Fawcett, Chicago, Illinois. In southern Illinois and Missouri—excluding the coal-fields of Missouri—

a Professor W. B. Potter, of Washington University, Saint Louis, Missouri. In Alabama, Professor Eugene A. Smith, of the University of Alabama, Tuscaloosa, Alabama. In Maryland, Dr. L. B. Hall, of Johns Hopkins University, Baltimore, Maryland. In Georgia, Dr. George A. Little, Atlanta, Georgia. In Tennessee, Mr. J. G. Cantrell, Nashville, Tennessee. In Kentucky, Mr. John R. Proctor, Frankfort, Kentucky. In North Carolina, Professor John C. Kerr, Raleigh, North Carolina. In Indiana, Colonel Ensign Bennett, Indianapolis, Indiana. In Maine and Vermont, Professor N. S. Shaler, of Harvard University, Cambridge, Massachusetts, with Messrs. J. E. Wolff and J. M. Wilson, assistants. In New York, New Jersey, Massachusetts, and Connecticut, Professor John C. Smock, of Rutgers College, New Brunswick, New Jersey. In Virginia and West Virginia, Mr. Jed. Hotchkiss, of Staunton, Virginia. In Michigan, Mr. George A. Fay, of Marquette, Michigan. In Wisconsin, Professor T. C. Chamberlin, assisted by Mr. James Wilson, jr., of Beloit, Wisconsin.

b These gentlemen carried out the duty assigned them of visiting the mines in their respective districts, either in person or by deputy, and of filling the schedules from inquiries made on the spot, with zeal and intelligence.

In that part of the mineral-producing field not assigned to any of the above gentlemen, viz, the coal-fields of Missouri, Kansas, Arkansas, and Texas, the mineral statistics were gathered, on the blank prepared by the Census Office, by the regular civil enumerators and forwarded to this office for tabulation. In the part of the country west of the 100th meridian the schedules of the non-precious minerals heretofore enumerated were collected by the western divisions of the United States Geological Survey, and the schedules, when regarded as complete, were sent to this office to be tabulated. It will therefore be seen that the duties of this office with regard to the statistics of mining were very different in different parts of the country, and, further, that the statistics were collected on blanks of different form. The lack of uniformity in this respect added greatly to the labor of tabulation.

c When the work as originally commissioned was well under way, this office undertook the additional duty of gathering the statistics of the minor mineral production. As many of the special agents had canvassed their respective districts before it was understood that the work was to be thus extended, there was no alternative but to attempt to gather the additional material through the very unsatisfactory medium of correspondence. Many of these substances are produced in out-of-the-way localities and in small quantities. Their importance is rapidly increasing, and an effort has been made to gather the statistics of them as fully as possible, if for no other purpose than to make a basis for subsequent censuses.

The "minor minerals" were supposed to include asbestos, asphaltum, barytes, chromic iron ore, cobalt, corundum, garnet, graphite, glass-sand, hydraulic cement and hydraulic lime, infusorial earth, kaolin, manganese, magnesian limestone, mica, nickel, ocher, oil-stones, pyrite, quartz, feldspar, scythestone, whetstone, and soapstone.

d It was understood that the production of the following minerals was excluded from the consideration of this office: The precious metals and quicksilver, petroleum, potter's clay, fire clay, building stone, paving stone, brick clay, molding sand, salt, gypsum, phosphates, and all fertilizing material. The production of grindstones was also necessarily excluded, since they are made in quarries whose chief product is building and flag stones.

In accordance with the broad, general plan of the census it was decided, with the sanction of the Superintendent of the Census, that in addition to the general statistical canvass of the mining industries, especial attention should be devoted to the iron-ore industry. And this special investigation was accorded to the iron-ore industry because of the varied composition of the ores, and the relation of this variation to the several special processes of manufacture of iron and steel; because of the commercial relation existing between the quality of the ores and their position with reference to distance and means of transportation to consuming centers; because the capacity of the different e ore-fields is unknown, and, finally, because of the bearing of all these factors, considering the entire country, upon the relation of a great fundamental industry to foreign competition and to numerous questions in political economy.

The investigation of the iron ores was directed to determining—

1. Their classification.
2. The distribution, geographically and geologically, of the different varieties.
3. The manner of occurrence of the different varieties.
4. The chemical character of the different varieties down to the products of each mine.

This special study required an expert survey in detail of all the mining districts and known undeveloped iron-ore deposits of the country. The experts, Messrs. Bailey Willis, Bayard T. Putnam, William Chauvenet, Edward R. Benton, visited every mining district and, excepting the carbonate districts of Pennsylvania, Ohio, and West f Virginia, almost every mine and known deposit in the United States and territories. After the necessary study of the mode of occurrence of the ore and of the extent of selection in mining in each mine, careful differential samples were taken of each variety of the ore in order to determine the influence of the separate varieties in each mine upon the metallurgical character of the whole output. These were commercial samples, from the mines and from the stock-piles, each sample consisting of ten to twenty pounds of small chippings.(a) These samples accompanied by hand-specimens of the different varieties making up each sample, were forwarded to the Newport office. Altogether there were collected nearly fourteen hundred samples.

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a This method, which has been found by numerous control tests to give in careful hands excellent results, was, I believe, first proposed and used by Major T. B. Brooks in the geological survey of the iron-ore districts of Michigan, and subsequently by the writer in the geological survey of Missouri.

The original intention was to extend the chemical study of each sample to the determination of all points of a metallurgical importance, making complete analyses of the soluble and insoluble constituents in all cases where it seemed desirable to do so. But early exhaustion of the census appropriations necessitated an extensive curtailment of the plan, and the complete analyses were confined chiefly to the more important ores of the Archæan, and the partial analyses largely to the determination of iron, phosphorus, and sulphur, and generally to noting incidentally the presence of titanium and manganese. One departure from the usual custom needs perhaps to be explained here. It is usual to give the amount of phosphorus, as of all other constituents, only in percentage of the ore; but since a knowledge of the amount of this element present in an ore is of vital importance in regard to steel manufacture, and since it becomes practically all concentrated in the pig, it was thought desirable to give also the phosphorus (phosphorus-iron) ratio (*i. e.* per cent. of phosphorus divided by per cent. of iron). This has been b calculated throughout and given with each analysis. It shows the amount of phosphorus in 100 parts of the iron contained in the ore; and as this impurity is practically wholly concentrated in the pig the phosphorus ratio shows the per cent. of phosphorus that would be contained in the pure iron (*i. e.*, the pig free from carbon, silica, etc.) were the ore smelted with pure fluxes without intermixture with other ores. As a matter of fact, since the pig contains only about 95 per cent. iron, the ratios given multiplied by 0.95 will give a closer approximation to the amount of phosphorus in the pig.

In all there were made 93 complete and 1,157 partial analyses, embracing over 4,400 determinations. Although the work was thus curtailed the complete set of the powdered samples and the full collection of the hand-specimens are preserved in the National Museum.

To partially cover the incompleted part of our own work, I am able, through the courtesy of Professor Lesley, to give a large number of analyses, by Mr. Andrew S. McCreath, of those ores of Pennsylvania not analyzed by c ourselves. Mr. McCreath very kindly selected the analyses representing samples taken to express averages.

The following table will show the number of samples collected in each state:

Total number of samples, 1,377, apportioned as follows:

Alabama	77	New York	156
British Columbia	1	North Carolina	67
California	4	Ohio	93
Colorado	32	Oregon	3
Connecticut	18	Pennsylvania	133
Delaware	4	Rhode Island	1
Georgia	61	South Carolina	5
Kentucky	34	Tennessee	148
Maine	3	Utah	28
Maryland	48	Vermont	10
Massachusetts	11	Virginia	100
Michigan	136	Washington territory	1
Minnesota	8	West Virginia	19
Missouri	49	Wisconsin	12
Nevada	1	Wyoming territory	2
New Hamshire	1		
New Jersey	109	Total	1,377
New Mexico	2		

d

Of these samples there were analyzed the aggregate numbers set down opposite the names of the respective districts in the following table: e

	Partials.	Complete.	Total.		Partials.	Complete.	Total.		Partials.	Complete.	Total.
Alabama	71	6	77	Minnesota	8	.....	8	South Carolina	5	.....	5
British Columbia	1	.....	1	Missouri	44	5	49	Tennessee	133	15	148
California	4	.....	4	Nevada	1	.....	1	Utah	28	.....	28
Colorado	32	.....	32	New Hampshire	1	.....	1	Vermont	9	1	10
Connecticut	17	1	18	New Jersey	104	5	109	Virginia	88	12	100
Delaware	4	.....	4	New Mexico	2	.....	2	Washington territory	1	.....	1
Georgia	43	4	47	New York	151	5	156	West Virginia	15	.....	15
Kentucky	33	1	34	North Carolina	58	9	67	Wisconsin	10	2	12
Maine	2	1	3	Ohio	93	.....	93	Wyoming territory	2	.....	2
Maryland	48	.....	48	Oregon	3	.....	3				
Massachusetts	11	.....	11	Pennsylvania	24	.....	24	Total	1,157	93	1,250
Michigan	110	26	136	Rhode Island	1	.....	1				

f

This special survey presents undoubtedly a very truthful picture of the iron resources of the country, and the tables and graphic plates, respectively, which are the combined result of the investigation of the ores and of the statistical canvass, show how perfectly the two methods supplement each other. The chemical work was carried out by Mr. A. A. Blair, assisted by Mr. F. A. Gooch, Captain John Pitman, United States Ordnance, Mr. J. F. White, Mr. Edward Whitfield, Mr. W. T. Richmond, and Mr. Charles F. King.

a The statistical work of my department was begun with an absence of definite instruction, and of special knowledge or experience in the art of gathering statistics, and was therefore necessarily tentative throughout its entire course. Much ground had to be gone over twice at an increase of time and labor, and no one can appreciate more fully than I do the incompleteness of the result. The following suggestions are made in the hope that they may save our successors in 1890 some of the annoyances to which our lack of experience subjected us.

GENERAL SCOPE OF THE INQUIRY.

b Taking it for granted that the primary object of the United States Census is economic information, and that the technical investigation of the mining industries is to be strictly subordinated to that object, the following points would seem to be the ones which should be regarded as essential. The schedule should be so framed as to make the leading question under each head prominent and distinct, and answers to them should be insisted on in all cases:

1. The number of mines, or separate "industrial establishments".
2. The location of each and name of manager.
3. The product for the census year.
4. The value of the product at the mine when ready for delivery.
5. The average number of hands employed.
6. The amount paid yearly in wages.

c 7. The number of months run.

8. The value of the material or mine supplies consumed annually.
9. The number and horse-power of steam-engines in use.
10. The value of the machines used.
11. The value of the fixed and floating capital.

Each of these heads can be so subdivided that the answers will furnish all the economic features of the industry. The subdivisions could be carried so far as to furnish full technical information in addition, but it must be remembered that the schedule must be adapted to mines under many different conditions, and that it must be framed with regard to ready and accurate tabulation. The danger in a multiplicity of questions—as our experience plainly showed—lies in the fact that many will be unanswered, and the important ones will probably be among them. If d special information is desired, either geological, mechanical, technical, or social, it can be best obtained from well-developed and established mines. It should form the subject of a special report, and its value will depend on the zeal and sagacity of the agent. It may be observed in passing that no schedule can be framed containing more than ten questions which will not be erroneously filled up in a majority of cases if left to the manager of the mine; not so much from reluctance or carelessness as from the fact that the scope and meaning of questions will be interpreted differently by different persons. The value of the statistics following depends upon the fact not only that the industries have been more thoroughly canvassed than ever before, but that the questions have been asked and the answers written down by agents who comprehended the general bearing of the inquiry.

Our experience suggests the following remarks on the schedule of questions best adapted to gather the statistics of the mining industries, and applicable to all mines.

e

MEANING OF THE TERM "ESTABLISHMENT OF INDUSTRY".

The census tabulation is limited to mines which have been productive during the census year; for, though mines which have been abandoned and which would have a value if reopened, and mines which have been recently opened but have not marketed their product during the census year, are both part of the sum total of our mineral property, an attempt to include them would involve the danger of dealing with speculative and unreal values, a danger which can not be too carefully avoided. It is evident that the enumeration of producing mines at any given time must include some which have been recently opened and some which are about to die, and must therefore f bring in as much of the growth and decay of the individual units of the industry as is necessary to a true presentation of its condition.

The question what constitutes a mine or "establishment of industry"—the unit of the Census—is not always easily settled. The definition of the mine engineer, of the mining company, and of the political economist would be very likely to be based on different discriminations. No one would think of calling the Calumet and Hecla openings two mines, although they are in reality two separate industrial establishments under one general head, nor of calling the sixty-five collieries of the Reading Coal and Iron Company one industrial establishment, although they are united in ownership and under the same supervision. The gatherer of statistics is obliged to accept the mercantile definition of the place. The term "establishment of industry", as used in these tables, may be taken to mean a mining operation the accounts of which are separate and the product of which is not mingled with that of any other before it is shipped, though at the same time it may consist of numerous distinct mine openings. We

are obliged to accept the statistics as they are kept by the operators, although so doing may disguise the extent to a which the ownership of our mineral resources is becoming concentrated in a few hands. That fact could of course be shown by an analysis of the returns. The "establishments" number 4,520, and their individual annual product varies from $200 to over $4,000,000.

THE LOCATION OF THE ESTABLISHMENTS.

If a complete and exhaustive list of mines could have been obtained in advance, the labor of collecting statistics would have been very much simplified. No such list existed in any state at the beginning of the census work, except, perhaps, in the iron and copper district of Michigan. The agents were obliged to supplement their own knowledge by inquiries of those best informed. The difficulty of obtaining a list of the producers of minor minerals b in so large a country as the United States was increased by the fact that they are generally mined in remote localities and in small quantities. It is possible that the system of state inspection of coal mines may hereafter be so perfected as to supply all that may be desired for that industry in this respect. We have included in our publications a list of the names and addresses of all mine operators that we have reached, believing that such a list, though necessarily growing more imperfect each year, would be valuable in many ways, and especially so in furnishing a starting point for compiling a preliminary list for the next census. It will also serve to test the thoroughness of the present canvass.

THE TONNAGE OF THE PRODUCT. c

The yearly product is taken from the books of the producers in by far the greater number of cases. The following comparisons with independent sources will substantiate the claim to as great accuracy and completeness as the nature of the work admits. Mr. Swank, in his report on the iron and steel industries, returns 7,709,706 tons as the amount of iron ore reduced in furnaces, etc., in the United States during the census year. If we add to the total amount mined the amount imported—439,451 tons—we have a grand total of 8,414,257 tons as the available ore "brought into sight" in the country during the same period. The difference—704,551 tons—is explained by the loss on handling, estimated at not far from 2 per cent., and by the fact that in consequence of the scarcity and high price of ore in the spring of 1879 the stocks on hand were brought down to the lowest point. The year was marked by great activity in iron mining, many new mines were opened, and the stock on hand in the spring of d 1880 was much greater than that on hand at mines and furnaces a year earlier.

The total of the production of anthracite given in the following tables for Pennsylvania reaches 28,640,819 net tons. The reports of the *Inspectors of Mines* of Pennsylvania for 1879 give 26,142,689 gross (=29,279,801 net) tons, and for 1880, 23,437,242 gross (=26,249,711 net) tons as the annual production of anthracite coal. Although a large proportion of these last is apparently estimate, it affords confirmation of their accuracy that our total for a period which covers part of both years falls between them. The same reports afford confirmation of the fullness of our returns of the tonnage of bituminous coal, the two figures being 18,837,962 net tons, as given by the inspectors and, including the irregular product, 18,425,163 net tons for the year terminating seven months earlier, as given by the census. No more perfect agreement could be desired in view of the fact that the annual increase of production in that state is 6 per cent., nor would a more perfect agreement afford more convincing proof of e substantial accuracy.

There is a class of small producers, principally of bituminous coal and iron ore, which from the strict economic standpoint should be kept distinct. It consists of farmers who having an outcrop of coal or a bed of soft ore on their land, do a little irregular surface-work during the fine weather of the winter or in the interval between seed-time and harvest. The coal produced in this manner is used for a local domestic fuel, and does not find its way into the general market. There are over 5,000 of these small producers, principally in the states of Pennsylvania, Ohio, Kentucky, and West Virginia, and their entire product amounts to less than three-quarters of a million of tons. As no capital is employed and but very little labor hired, this mining cannot be said to have any influence on the industry at large. The arbitrary rule to exclude from consideration any establishment not producing yearly as much as $500 worth for sale would cause this local gathering of fuel to be overlooked entirely. Iron ore raised f in this small way is sold to some neighboring blast-furnace, and goes to swell the general product of manufactured iron. It amounted during the census year to 909,977 tons, but involved the employment of very little capital or hired labor. The product is cheap and low-grade ore, and the industry is entirely distinct from underground mining by a well-organized establishment.

A great part of the lead mining of the northwestern district—Iowa, Illinois, and Wisconsin—is of this same irregular and desultory character, so much so that it proved impossible to obtain returns of all the lead ore produced there from the miners themselves. Mining there consists of prospecting. The ore is found in irregular deposits and sold to smelters. As soon as the deposit is exhausted, which may occur a few days after it is found, the pit is abandoned, and the two or three miners working on a royalty in partnership go elsewhere. The ore-

a smelters' accounts of purchases are, therefore, in these states, the only source from which the total product of lead and zinc can be obtained. They were very thoroughly and energetically canvassed by Mr. George H. Eldridge, from this office, and in estimating the lead- and zinc-ore product are to be taken in preference to the miners' returns.

The copper returned in the mining tables should be slightly increased in order to arrive at the entire production of that metal, as a small quantity reaches the market as a by-product in the mining of the precious metals. Lead, also, is very generally associated with silver and shipped in the form of base bullion. This portion of the product does not appear in our returns of lead mines.

In some cases the mining industry is restricted to mining, pure and simple; in others, a certain amount of labor is expended in preparation for market. Thus the anthracite mines are invariably connected with a "breaker" or building in which the coal is reduced to uniform size. The Lake Superior copper mines crush and wash b the rock they mine, in order to send to the smelting establishments material containing as high a percentage of metal as possible, and some producers of iron ore roast or calcine it before delivery. Where these operations are so interwoven with the business of mining as to be inseparable, they are taken to constitute a part of the mining industry; where they are separable or conducted at a distance, they are regarded as a part of the business of reduction or manufacturing, the statistics of which were compiled by other hands. Our aim has been to draw the line rigidly at mining statistics, lest we might duplicate items of capital or labor which appeared in the summation of other branches of industry. The statistics of smelting establishments given in this report are independent of mining operations.

VALUE PER TON OF THE PRODUCT.

c It follows, therefore, that the value of the mining product is taken at the pit's mouth, or rather at the point where the labor reported ceases to act on it, where it is delivered for transportation to a new owner. This accounts for the low average price returned, at least in the case of coal and iron ore, which are more than doubled in price before they reach the consumer.

LABOR AND WAGES.

The accurate determination of the number of men supported by any industry furnishes the most trustworthy criterion of its relative importance. The number of boys under sixteen years of age employed has always been made the basis of a question on the schedule, which should contain also a general inquiry into the system of labor. In most branches of non-precious mineral production the underground force is paid by the ton of product, and not d by the day, and furnishes at its own cost a considerable amount of material, as powder, fuze, etc., which on the pay-roll may appear as wages instead of mine supplies. Care has been taken to guard against this error, and to include under the head of wages remuneration for labor only. Steadiness of employment is also an important factor in the labor question, and we have, therefore, endeavored to ascertain the number of days of enforced and voluntary idleness as well as the net pay received. How irregular the periods of employment are in the mining industry may be seen from the following comparative table for the census year of 1880:

e

Kind of mining industry.	Average per cent. of year worked.	Average per cent. of year lost in strikes.	Average per cent. of year lost from other causes.
Anthracite coal	70.68	0.72	28.60
Bituminous coal	75.70	6.68	17.62
Iron ore	77.55	0.02	22.43
Copper	100.00	0.00	0.00

The column neaded "Average per cent. of year lost from other causes" does not include the time lost by reason of holidays, temporary inability on the part of the individual, etc., but only the time lost by the suspension of mining operations from overproduction, lack of means of transportation, etc.

MATERIALS CONSUMED.

f This is of course not as important a question in the mining industry as it is in those which operate on raw material. Mine supplies consist of powder, fuze, timber, lumber, fuel, feed for animals, machine extras, wire cables, rails, etc. The inquiry under this head should be itemized as far as possible.

CAPITAL EMPLOYED.

This is the subject on which questions are most likely to be resented and the answers misleading or based on erroneous conceptions. If the question is simply, How much capital is employed in your business? it may be considered an inquiry into a strictly private matter; the answer may refer to what would remain after the debts were paid; or some such unsubstantial thing as "the good will of the business" may be included. In case the

producer is an incorporated company, the answer will be the amount of share capital at par, which is carried as an a
indebtedness on the books. In nearly every case it will be an estimate in round numbers of something which may or may not be the subject-matter of the inquiry. What the present investigation has sought to ascertain is, the value of the mineral property of the country as a producer of actual values, that it might be ranked with the other great divisions of productive energy with regard to its real importance. From this point of view the question of ownership and indebtedness, which occupies the most important place in the mind of the operator, may be disregarded. If the mine is worked on a royalty the operator would naturally omit the real estate in estimating his assets, whereas it is in reality the most important part of mining capital. The questions should therefore be framed with a view to ascertaining the value of the entire mining establishment, and not merely the mercantile capital of the lessee. They were: What is the value of the mineral real estate attached to the mine? What is the value of the plant? and how much is usually employed as working capital? The second question should perhaps b
have been divided into: What is the value of the fixed plant; and what is the value of the movable plant and equipment? The third question covers an item of mineral property which might be overlooked; that is, the product on hand or in transit which has been paid for out of the floating capital, and the receipts for which are deferred in the ordinary course of business.

The result of this form of inquiry has been to increase very greatly the amount returned as "capital of the mining establishments", without including anything of a speculative or artificial value, nor the great body of mineral-producing land which is not productive at present, and is in reality the property of the next generation.

POWER AND MACHINERY. c

The question of labor is closely connected with that of labor-saving machinery, and no intelligent analysis of the one can be made which does not take into account the increasing effect of the other. At the same time, to complicate the schedule, which must be applicable to all classes of mines, with technical questions on machinery, will not result in any definite information, and is very likely to weaken it as a register of economic statistics. Such information can be gathered only by a special study of typical mines, and can be conveyed only through the medium of detailed descriptions and drawings. The number, value, and horse-power of the engines, and the value of the machinery, can be gathered on the statistical blank and entered in the final tables. The agent can, of course, enter on a separate note-book matter for a report on any technical features.

The question of movement of mineral product, final destination, freight-rates, etc., can be investigated through the returns of transportation companies. Such information is not generally to be obtained from the managers of d
mines who have nothing to do with the product after it is shipped.

In conclusion, we wish to express our obligations to mine managers and owners. We have received returns from 4,520 regular establishments and more than 6,000 small producers. Information has been rudely refused in two cases only, and withheld from narrow views of the utility of statistics in two or three more. In such cases we have made no attempt at legal coercion, but have obtained the information as best we could from other sources. Had the census year coincided with the calendar year ending December 31, the labor of gathering the statistics would have been very much simplified.

The manuscript of this volume, excepting the portion relating to the Cretaceous coals of the northwest, and some discussions left to be added to the proof, was forwarded to the Superintendent of the Census in 1882. The lateness of its publication is due to the limited means at the disposal of the Bureau. Since the completion of the main e
body of the volume there was carried out, under the direction of the writer, and for the Northern Transcontinental Survey, an extensive and systematic exploration of the Cretaceous coal-fields of the territories of Montana and Washington, as well as of part of the lignite-bearing fields of Dakota. At the time of the suspension of this survey the results of this exploration were undigested and unplatted. To avoid the loss of results that had cost over $100,000, the writer had the topographical work platted and the coals analyzed largely at his own cost, but partly also through the generous co-operation of the members of the survey in whose provinces the work naturally belonged It seemed, therefore, eminently proper that these results should be contributed to the census. It remains to be added, that, with the exception of the topography, this work on the Cretaceous coals was executed by gentlemen who were special agents under me in the census work proper—Messrs. Eldridge, Willis, Putnam, and Wolff in the field work, and Dr. F. A. Gooch in the laboratory. To Mr., now Professor, Charles F. Johnson, jr., much of the f
success is due, both in planning and executing the statistical canvass; and many of the tables of analyses and of comparison with the Census of 1870, as well as the discussions of those tables, were planned and calculated by him. The tabulation of the returns and the very voluminous correspondence needed to perfect the schedules was done by Mr. T. Nelson Dale, to whose care and tact much more of the successful result than appears on the surface is due. In addition to the large and valuable portion of the samplers' notes, in the part relating to iron ores, contributed by Mr. Bayard T. Putnam, nearly the whole work of editing has been executed by him.

RAPHAEL PUMPELLY,

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a TABLE 1.—*Condensed statement of mineral production of regular mining establishments for the United States, by substances.*

1880. b	Number of states and territories.	Number of counties.	Number of establishments.	Tons of 2,000 pounds produced during census year 1880.	Value of product.	Value of materials consumed.	Men employed.	Boys employed.	Total hands employed.	Wages paid.	Number of steam-engines.	Horse-power of steam-engines.	Value of all machinery, including engines.	Capital employed and invested.
Bituminous coal and lignite (a).	24	335	2,989	41,850,054	$52,427,868	$4,860,493	93,817	6,299	100,116	$32,601,500	855	26,168	$2,668,861	$103,109,807
Anthracite coal	3	11	277	28,621,371	42,139,740	6,732,592	54,616	16,132	70,748	22,693,407	1,067	105,807	13,908,415	154,504,336
Iron ore	23	160	805	7,064,829	20,470,756	2,894,011	30,080	1,588	31,668	9,538,117	821	24,838	3,211,548	61,782,287
Copper ore	10	10	28	993,161	8,832,836	1,381,334	5,745	270	6,015	3,077,403	129	13,276	2,622,800	31,570,956
Lead and zinc ore	10	29	206	177,008	3,837,761	331,970	7,323	160	7,483	2,640,265	167	6,739	476,295	7,442,983
Minor minerals	21	83	189	.....	3,387,444	625,347	4,026	176	4,202	1,305,222	86	5,058	.....	6,262,315
Total	.....	628	4,494	.....	131,096,405	16,825,747	195,607	24,625	220,232	71,855,914	3,725	181,886	22,887,919	364,672,684

a Inclusive of semi-anthracite from Pennsylvania but exclusive of Utah lignite, as the statistics from this territory did not reach office until after table was made.

c TABLE 2.—*Averages applicable to mineral products, from regular establishments, from Census of* 1870 *and* 1880, *in the United States.*

Kind of mineral product. d	Value of machinery per ton raised, 1880.	Value of machinery per dollar of product, 1880.	Tons raised per horse-power of engines, 1880.	Tons raised per horse-power of engines, 1870.	Value produced per horse-power of engines, 1880.	Value produced per horse-power of engines, 1870.	Materials used per ton, 1880.	Materials used per ton, 1870.	Wages paid per ton, 1880.	Wages paid per ton, 1870.	Value produced per hand per year, 1880.	Value produced per hand per year, 1870.	Tons raised per hand per year, 1880.	Tons raised per hand per year, 1870.	Wages paid per hand per year, 1880.	Wages paid per hand per year, 1870.	Per cent. of value of product paid for labor, 1880.	Per cent. of value of product paid for labor, 1870.	Per cent. of value of product paid for materials, 1880.	Per cent. of value of product paid for materials, 1870.	Capital necessary for dollar of product, 1880.	Capital necessary for dollar of product, 1870.	Value of product per ton, 1880.	Value of product per ton, 1870.	Number of boys to 100 men, 1880.	Number of boys to 100 men, 1870.
Anthracite coal	$0 49	$0 33	271	357	$398	$876	$0 24	$0 23	$0 79	$1 47	$672	$793	456	323	$362	$474	54.0	60.0	16.0	9.0	$3 66	$1 33	$1 47	$2 46	30.0	20.0
Bituminous coal	06	05	1,599	929	2,003	1,894	12	19	80	1 24	541	852	431	418	336	519	62.0	61.0	9.3	9.4	1 96	1 68	1 25	2 04	6.7	2.8
Iron ore	45	16	284	396	824	1,542	41	38	1 35	2 01	663	889	229	229	309	460	46.6	51.7	14.0	9.7	3 01	1 34	2 90	3 89	5.3	2.3
Copper ore	2 64	30	74	111	665	823	1 39	84	3 09	3 83	1,502	978	169	133	523	509	30.6	52.0	15.6	11.2	3 58	1 50	8 89	7 37	4.7	3.3
Lead and zinc ore	2 69	1 20	26	....	569	215	1 87	.....	14 91	.....	518	904	24	....	356	356	68.8	39.4	8.6	5.2	1 93	1 98	21 68	.....	2.2	3.2

TABLE 3.—*Percentages of gain in the factors of the mining industries (regular establishments) since the Census of* 1870, *in the United States.*

e Kind of product.	Increase in number of men employed.	Increase in number of boys employed.	Increase in total employés.	Increase in value of entire product.	Increase in tonnage of product.	Increase in value of materials used.	Decrease in yearly wages paid per hand.	Increase in total wages paid.	Increase in total capital.	Increase in horse-power of engines.	Change in value of yearly product per hand.	Increase in tonnage raised yearly per hand.	Change in per cent. of value of product paid for labor.	Change in per cent. of value of product paid for materials.	Change in price per ton of product.
Anthracite coal	24.0	77.6	33.2	9.4	82.7	86.9	23.6	b 1.4	202.8	116.6	b 15.2	41.1	b 10.00	a 77.77	b 40.24
Bituminous coal	131.3	468.5	116.3	49.6	143.3	134.9	35.2	53.0	74.7	95.8	b 36.5	3.1	a 1.80	b 1.06	b 38.72
Iron ore	105.0	343.5	110.8	55.0	108.0	126.1	32.8	39.4	247.6	189.4	b 25.4	0.07	b 9.80	a 44.33	b 25.45
Copper ore	9.7	57.8	11.3	69.8	.....	135.5	a 2.7	13.4	305.3	110.1	a 53.5	27.0	b 4.11	a 39.28	a 20.61
f Lead and zinc ore	340.8	201.8	297.1	151.6	.....	321.8	00.0	339.5	145.7	607.1	b 42.6	.....	a 74.61	a 65.36	.....

a Increase. b Decrease.

REMARKS ON TABLE 1.

This table was compiled with a view to the comparison of the economic features of the industries in 1880 and 1870. Consequently, it covers the production of the regular mining establishments only, excluding the "farmer-miner". From these last 5,368 returns were received, aggregating 909,977 tons of iron ore and 916,569 tons of bituminous coal.

The statistics of the copper-mining industry, as given in table No. 1, are restricted to the production of the country east of the 100th meridian. The copper mining in Arizona, California, etc., results not in the production of copper alone, but in that of "copper matte", an alloy or mixture of copper and other metals, which is sold in

the East to be refined. The copper ore east of the 100th meridian is, however, valuable for the copper alone, with a few exceptions. The amount of copper produced from both sources, as taken from the statistics of smelting-establishments, is—

	Pounds metallic copper.
Refined in eastern works	9,041,884
Smelted in western works (all lake Superior)	45,130,133
Total	54,172,017

The statistics of lead and zinc, which are given together for the reason that in the northwestern district—Illinois, Iowa, and Wisconsin—they are generally produced from the same mine, covers all the mining returns where either of those metals was the main product. b

The mining returns of the northwestern district, when it was out of the question to gather the full statistics from the miners themselves, for the reasons already alluded to, have been increased to make them correspond to the amounts of lead and zinc ore which the smelters returns showed were produced there during the census year. In the county tables, however, they are given as they were received, though much below the truth. The total annual yield of these metals, taken from the statistics of the smelting-establishments, is as follows:

Lead.	Pounds.	Zinc.	Pounds.
Smelted from ores	66,970,838	Metallic zinc or spelter	46,477,999
Refined from base bullion, the principal value of which was silver.	95,967,267	Zinc oxide produced in chemical works from ore, 20,213,631 pounds, equivalent to metallic zinc	16,203,460
Total yield of metallic lead, census year	162,938,105	Total metallic zinc, census year	62,681,459

c

RECAPITULATION.

The grand total of the production of coal, iron ore, and the non-precious metals embraced in this report would therefore be, bringing together the regular and the irregular production of coal and iron ore, and the actual production of copper, lead, and zinc as returned by the smelters, including that obtained as a by-product in precious-metal smelting, as follows:

		Amount.	Value.
Anthracite coal	tons	28,621,371	$42,139,740
Bituminous coal: (a)			
Regular product	tons	41,864,802	52,461,513
Irregular product	do	916,569	1,092,305
Total coal	do	71,402,742	95,693,558
Iron ore:			
Regular product	tons	7,064,829	20,470,756
Irregular product	do	909,977	2,686,201
Total iron ore	do	7,974,806	23,156,957
Metallic copper	pounds	54,172,017	9,462,253
Metallic lead	do	162,938,105	7,935,140
Metallic zinc	do	46,477,999	2,862,712
Zinc oxide		20,213,631	763,738
Minor minerals			3,387,444
Total value of all non-precious mineral product			143,261,802

d

e

a Includes the coal and lignite mined west of the 100th meridian.

REMARKS ON TABLES 2 AND 3.

The averages in Tables 2 and 3 are based on Table 1, and a corresponding table compiled from the Census of 1870. The values of 1870 were of course reckoned in the debased currency of the period. As remarked before, the industries considered are the mining industries proper, which are limited to the work of extracting the mineral from the ground and such preparation or dressing on the spot as is necessary to fit it for transportation. When f an industry is compound—embracing both mining and manufacturing—as, for instance, when a furnace company mines ore and reduces it to the state of pig-iron, that part of the return which relates to manufacturing has been carefully eliminated.

The "irregular production" by persons whose chief business was not mining does not enter into the totals in Table 1, and it was probably not included in the returns of 1870, at least in the case of the bituminous coal industry, since it is made up of very small individual contributions, much less in value than the limit of $500 annual product, which was then (and should hereafter) be taken to be necessary in order to constitute an "establishment of industry". The object of the census is, ultimately, the investigation of economic relations, or rather the furnishing the results by which such relations can be investigated, and not an endeavor to swell the arithmetical total of production by collecting items insignificant in themselves and unimportant in their aggregate effect on the industries of the country at large.

a The production of anthracite coal is so completely in the hands of large establishments that the small, irregular production has not been separated.

For the purposes of comparison, the irregular product of iron ore in 1880 is also rightly excluded from Table 1. The Superintendent states, page 749, volume 3, United States Census industrial statistics, 1870, that the iron ore raised in 1870 was then understated by an amount corresponding closely to the "irregular product".

The copper, lead, and zinc statistics, as compiled from the Census of 1870, correspond very closely in extent and scope to the statistics of those industries as given in Table 1 for 1880.

Therefore, Tables 2 and 3 present as nearly as possible a correct general view of the advance in the mining industries during the past decade.

The amounts of copper ore and rock mined was not specified in the Census of 1870, only the value of the product. b For the purpose of comparison, the weight of the ore and rock has been obtained from independent sources. It will be observed that this is the only mineral product which has increased in value per unit since 1870. This is owing to the increase in the per cent. of metal contained in the rock raised in the Lake Superior region, the leading mine being exceptionally fortunate in this respect.

The weight of lead and zinc ore was not specified in the Census of 1870, and no sufficient data have been obtained to estimate it. It is therefore necessarily omitted in the comparison tables.

No computations have been made in the returns of the minor minerals, as they embrace so many materials of different natures. The minor mineral production is, however, included in the totals, though not large enough to affect the percentages.

c TABLE 4.—*Product of the non precious mineral industries (regular establishments only), by substances and by states.*

State or territory.	Anthracite coal.	Value.	Bituminous coal and lignite.	Value.	Iron ore.	Value.	Lead ore.	Value.
	Tons.		*Tons.*		*Tons.*		*Tons.*	
Alabama			322,934	$475,559	184,110	$189,108		
Alaska								
Arizona								
Arkansas			14,778	33,535				
California			236,950	663,013				
Colorado			462,747	1,041,350				
d Connecticut					35,018	147,799		
Delaware					2,726	6,553		
Georgia			154,644	231,605	72,705	120,692		
Idaho								
Illinois			6,089,514	8,739,755			772	$30,200
Indiana			1,449,496	2,143,093				
Iowa			1,442,333	2,473,155			384	19,172
Kansas			763,597	1,498,168			10,681	460,080
Kentucky			935,857	1,123,046	33,522	88,930		
Maine					6,000	9,000		
Maryland			2,227,844	2,584,455	57,940	118,050		
Massachusetts					62,637	226,130		
Michigan			100,800	224,500	1,837,712	6,034,648		
e Missouri			543,990	1,037,100	386,197	1,674,875	28,315	1,478,571
Montana			224	800				
Nebraska			200	750				
Nevada								
New Hampshire								
New Jersey					754,872	2,900,442		
New Mexico								
New York					1,239,759	3,499,132		
North Carolina			350	400	3,276	5,102		
Ohio			5,932,853	7,629,488	198,835	448,000		
Oregon			43,205	97,810	6,972	4,669		
Pennsylvania	a28,640,819	$42,172,948	b18,075,548	18,267,151	1,820,561	4,318,999		
Rhode Island	6,176	15,440						
f South Carolina								
Tennessee			494,491	628,954	89,933	129,951	60	2,500
Texas								
Utah			14,748	33,645				
Vermont					560	2,750		
Virginia	2,817	8,290	40,520	92,837	169,683	384,331	11,200	33,000
Washington			[illegible]	[illegible]				
West Virginia			1,782,569	1,971,847	60,371	88,595		
Wisconsin					41,440	73,000	1,728	78,525
Wyoming			[illegible]	[illegible]				
Total	28,649,812	42,196,678	41,864,802	52,461,513	7,064,829	20,470,756	53,140	2,102,948

a Includes 28,441 tons irregular production.

b Includes 70,560 tons of semi-anthracite, valued at $110,000.

TABLE 4.—*Product of the non-precious mineral industries, etc.*—Continued.

State or territory.	Zinc ore.	Value.	Copper ingots.	Value.	Minor minerals.	Value.	Total value, excluding copper in states and territories indicated.
	Tons.		*Pounds.*		*Tons.*		
Alabama							$664,667
Alaska			3,933	(a)			
Arizona			3,183,750	(a)			
Arkansas							33,535 b
California			720,000	(a)	2,597	$19,948	682,961
Colorado			1,578	(a)			1,041,350
Connecticut							147,799
Delaware					14,510	163,310	169,863
Georgia			922	(a)		120,135	472,432
Idaho			150,000	(a)			
Illinois	3,000	$39,000				102,324	8,911,279
Indiana					7,599	22,291	2,165,384
Iowa							2,492,327
Kansas	7,248	131,169					2,090,317
Kentucky							1,211,976
Maine			(d)		1	2,000	11,000
Maryland	672	7,200	57,058		1,200	159,303	2,870,208 c
Massachusetts						101,970	328,100
Michigan			45,830,262	7,979,232		41,057	14,279,437
Missouri	34,344	599,373	230,717	25,730		13,196	4,828,845
Montana			1,212,500	(a)			800
Nebraska							750
Nevada			134,730	(a)	50		
New Hampshire			(e)			112,550	112,550
New Jersey	39,381	451,070			33,828	40,270	3,891,782
New Mexico			4,055	(a)			
New York						1,623,011	5,122,113
North Carolina			1,640,000	350,000		79,855	435,357
Ohio							8,077,488
Oregon							102,479 d
Pennsylvania	20,459	394,568	214,736	35,256		426,102	65,615,024
Rhode Island							15,440
South Carolina					7,427	27,709	27,709
Tennessee	3,699	23,145	(e)				783,550
Texas			5,084	(a)			
Utah							36,645
Vermont			2,647,894	469,495		48,788	521,033
Virginia	10,448	24,126	678	(a)		179,125	721,709
Washington							[illegible]
West Virginia						4,500	2,064,942
Wisconsin	4,617	64,562	18,087	1,549		100,000	317,636
Wyoming							1,080,451 e
Total	123,868	1,734,213	56,005,984			3,387,444	131,218,014

a Value of copper ingot not returned in these states and territories, and not estimated, because in some cases the copper occurs only as an accessory metallurgical product from the smelting of mixed ores, and also because its value depends partly on the cost of its transportation to market.

b Excluding 1,275 pounds returned by smelters, value not estimated.

c Copper ore was mined in this state, but not smelted; estimated to produce 34,050 pounds of ingot.

d Copper ore was mined in this state, but not smelted; estimated to produce 102,500 pounds of ingot.

e Copper ore was mined in this state, but not smelted; estimated to produce 153,880 pounds of ingot.

a TABLE 5.—*Coal and iron ore product by industrial fields east of the 100th meridian.*

ANTHRACITE COAL.

INDUSTRIAL FIELDS.	Product.	Value.	Horse-power.	Wages.	Materials.	Value per ton.	Horse-power of engines per ton of product.	Wages paid per ton of product.	Materials consumed per ton of product.
	Tons.								
Pennsylvania	28,612,595	$42,116,500	105,752	$22,664,055	$6,729,477	$1.47	.0037	$0.79	$0.24

b

BITUMINOUS COAL.

Pennsylvania, Tioga, Clearfield, and Bradford counties	3,162,193	$3,836,335	205	$1,836,444	$316,471	$1.21	.000065	$0.58	$0.10
Pennsylvania, exclusive of the above counties	14,842,795	14,320,816	5,186	9,027,139	1,438,131	.96	.000349	.608	.097
Ohio, West Virginia, and Kentucky	8,651,279	10,724,381	4,761	7,086,377	1,278,339	1.24	.000550	.819	.148
Maryland	2,227,844	2,584,455	840	1,370,079	194,942	1.16	.000386	.61	.09
Virginia and North Carolina	40,870	93,237	763	71,747	11,664	2.28	.018668	1.755	.285
Tennessee, Alabama, and Georgia	972,069	1,336,118	557	750,731	105,406	1.37	.000573	.77	.108
Missouri, Kansas, Iowa, and Nebraska	2,750,120	5,009,173	2,083	2,956,648	353,071	1.82	.000757	1.075	.128
Arkansas	14,778	33,535	35	20,850	1,135	2.27	.002368	1.410	.077
Michigan	100,800	224,500	235	146,000	7,750	2.23	.002331	1.448	.077
c Illinois	6,089,514	8,739,755	8,294	6,035,919	796,149	1.43	.001362	.99	.13
Indiana	1,449,496	2,143,093	1,717	1,405,164	158,604	1.48	.001184	.97	.11
United States east of 100th Meridian	40,301,758	49,045,398	24,696	30,707,099	4,661,662	1.217	.0006624	.762	.1157

IRON ORE.

Michigan	1,837,712	$6,034,648	6,574	$2,573,857	$939,711	$3.28	.00358	$1.40	$0.51
New York	1,239,759	3,409,132	8,039	1,507,395	534,395	2.82	.00245	1.21	.43
New Jersey	754,872	2,900,442	4,486	1,606,257	584,229	3.84	.00594	2.13	.77
All others	3,232,486	8,036,534	10,739	3,850,608	835,676	2.48	.00332	1.19	.26
United States	7,064,829	20,470,756	24,858	9,538,117	2,894,011	2.90	.00351	1.35	.41

PLATE I.—REPRESENTATION OF THE PROPORTIONAL AMOUNTS OF CAPITAL INVESTED IN "WORKING CAPITAL", IN "PLANT", AND IN LAND.

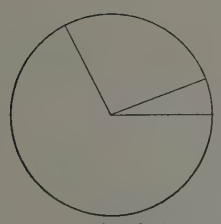
The areas of the circles represent the amounts of capital employed and invested in the various mining industries. The areas of the segments, measuring from end of horizontal diameter on the right towards the left, represent the proportional amounts of capital invested and employed as working capital; the areas of the next represent the values of the plant, machinery, buildings, fixtures, etc.; and the remainder, in each case, the value of the land. The circle representing the minor minerals is not divided, as the data were not complete for that purpose.

MINOR MINERALS.

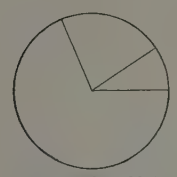
LEAD & ZINC.

COPPER.

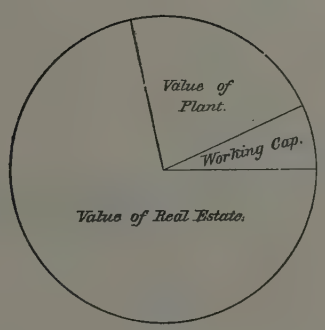
IRON.



ANTHRACITE COAL.



BITUMINOUS COAL.



Working capital,	$24, 544, 000
Plant,	81, 348, 800
Real estate,	259, 016, 524
Total capital,	$364, 909, 324

TOTAL MINERAL PRODUCT.

PLATE II.—REPRESENTATION OF THE DISTRIBUTION OF THE VALUE OF THE VARIOUS MINERAL PRODUCTS.

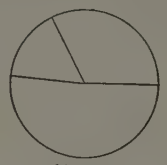
The areas of the various circles are proportional to the values of the products. The first segment in each, measuring from the right end of horizontal diameter to the left, represents the part of the value of the product paid for wages; the next segment the part paid for material consumed; the remainder represents royalty, profits, etc.

MINOR MINERALS.

Value of product, $3, 387, 444
Wages paid, 1, 305, 222
Material used, 625, 348

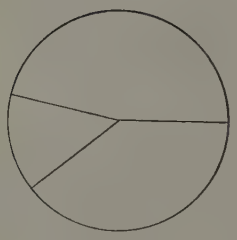
LEAD & ZINC.

Value of product, $3, 837, 761
Wages paid, 2, 640, 265
Material used, 331, 970



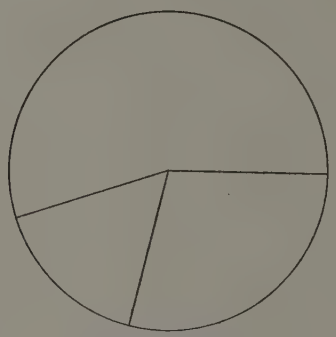
COPPER.

(b) Value of product, $8, 832, 836
(b) Wages paid, 3, 077, 403
(b) Material used, 1, 381, 334



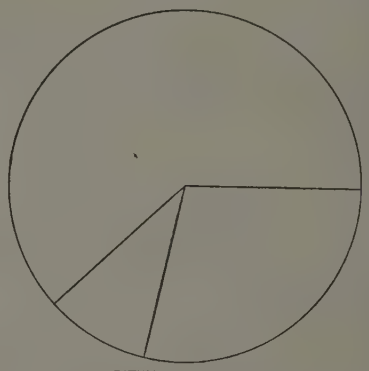
IRON ORE.

(a) Value of product, $23,156,957
(a) Wages paid, 10,074,728
Material used, 2,894,011



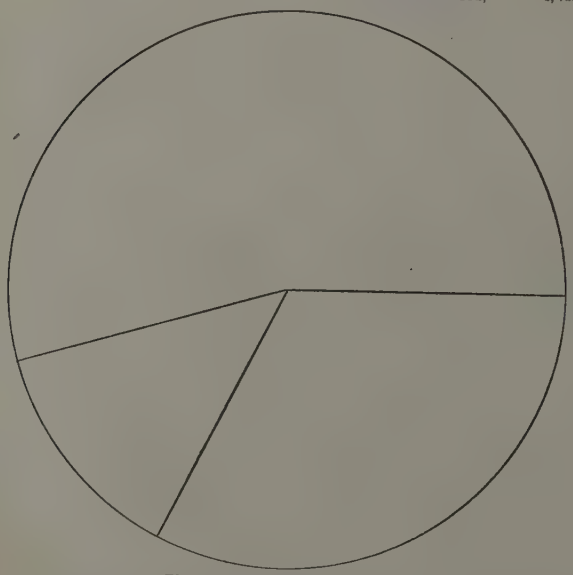
ANTHRACITE COAL.

Value of product, $42, 180, 748
Wages paid, 22, 693, 407
Material used, 6, 732, 592



BITUMINOUS COAL.

Value of product, $52, 351, 513
Wages paid, 32, 561, 175
Material used, 4, 853, 675



TOTAL MINERAL PRODUCT.

Value of product, $133, 747, 259
Wages paid, 72, 352, 200
Material used, 16, 818, 930
Royalty, profits, etc., 44, 576, 129

(a) Includes irregular product.

(b) Includes only copper east of 100th Meridian. See Table 49, p. 798.

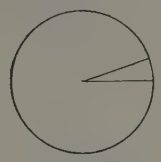
PLATE III.—REPRESENTATION OF THE PROPORTION OF ADULT HANDS TO BOYS UNDER 16 EMPLOYED IN EACH INDUSTRY.

The areas of the circles represent the total number of hands employed. The smaller segment represents the number of boys, and the larger the number of men.

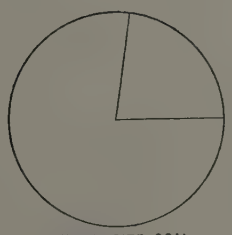
MINOR MINERALS.

LEAD & ZINC.

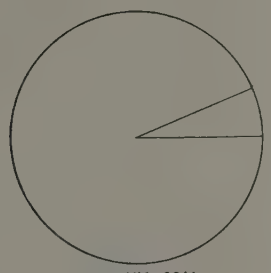
COPPER.



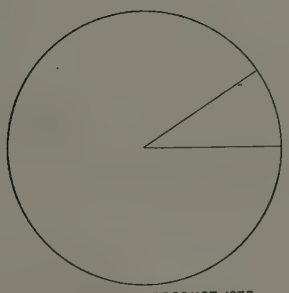
IRON ORE.



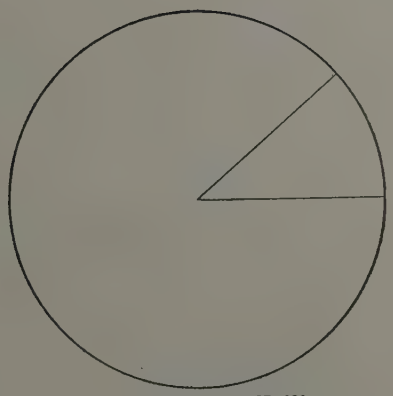
ANTHRACITE COAL.



BITUMINOUS COAL.



TOTAL MINERAL PRODUCT, 1870.



TOTAL MINERAL PRODUCT, 1880.

PLATE IV.—REPRESENTATION OF THE WEIGHT OF THE VARIOUS MINERALS TAKEN FROM THE EARTH DURING THE CENSUS YEARS OF 1880 AND 1870.

The areas of the circles represent the relative weights of the material taken from the earth, in the eastern district of the United States, in mining for the non-precious minerals. The copper rock contains about 2.8 per cent. of metal. The iron ore contains about 50 per cent. of iron, the coal is all merchantable product, the lead and zinc ores represent 30 per cent. of metal. No account is taken of the waste rock or culm removed in mining. When an inner circle is drawn it represents the corresponding tonnage as reported in 1870.

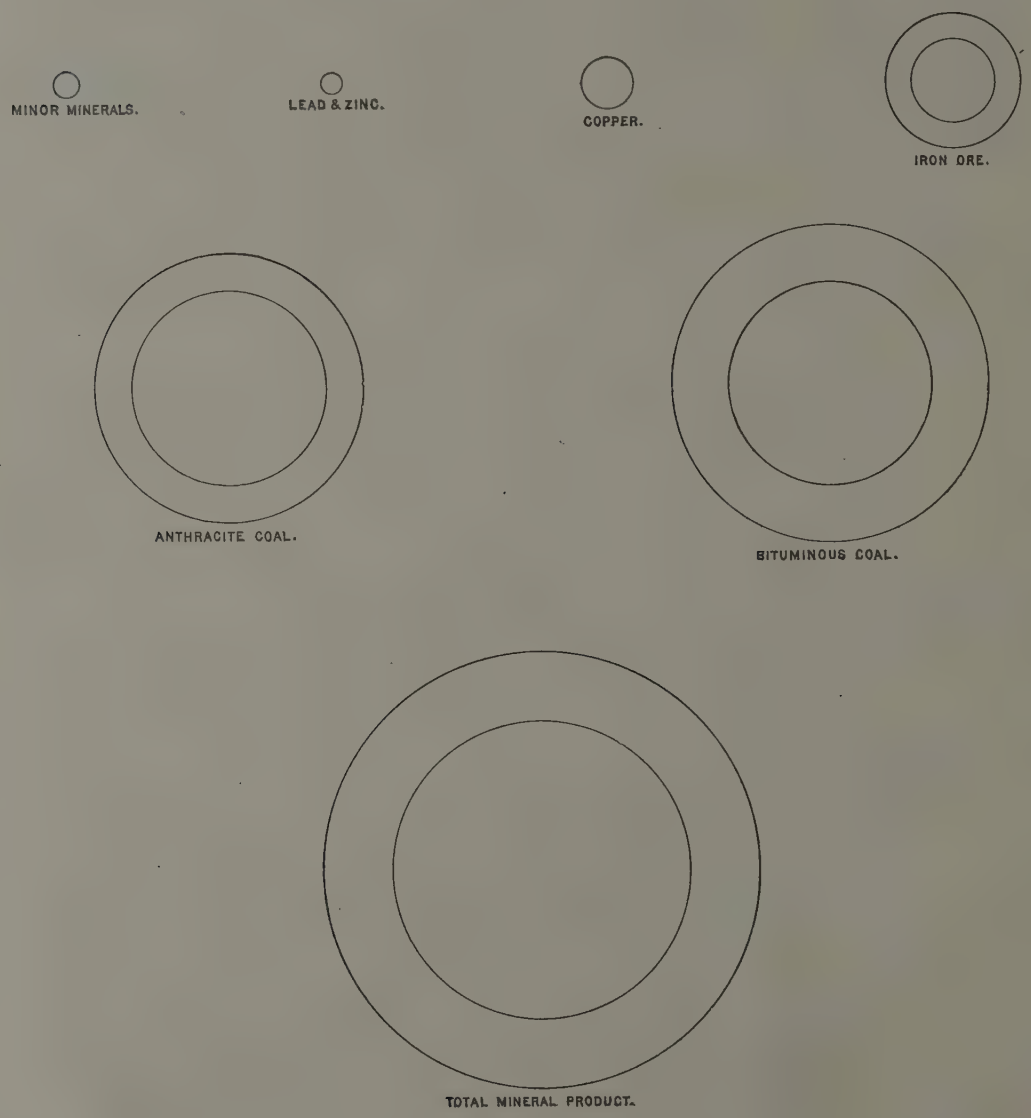
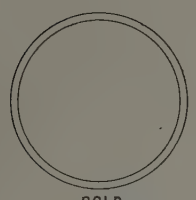
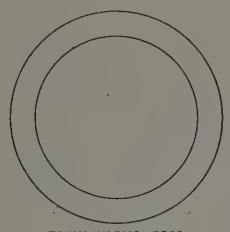


PLATE V.—REPRESENTATION OF CHANGES IN PRICES, WAGES, ETC., SINCE 1870 IN THE MINING INDUSTRIES.

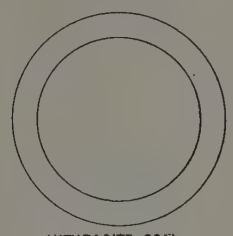
The outer circles represent the prices in 1870, and the inner circles the corresponding prices in 1880. The annular space represents the shrinkage during the included decade.



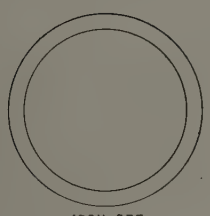
GOLD.
Shrinkage 13%
from 115 to 100



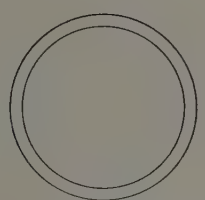
BITUMINOUS COAL.
Shrinkage 39%



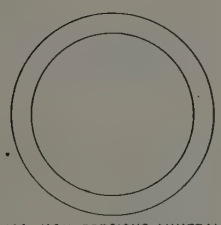
ANTHRACITE COAL.
Shrinkage 40.3%



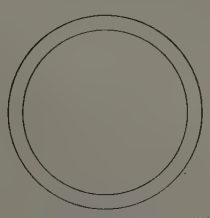
IRON ORE.
Shrinkage 25.5%



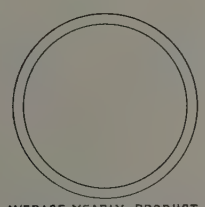
INGOT COPPER.
Shrinkage 24%



ALL NON-PRECIOUS MINERALS.
Average shrinkage of price 32.8%



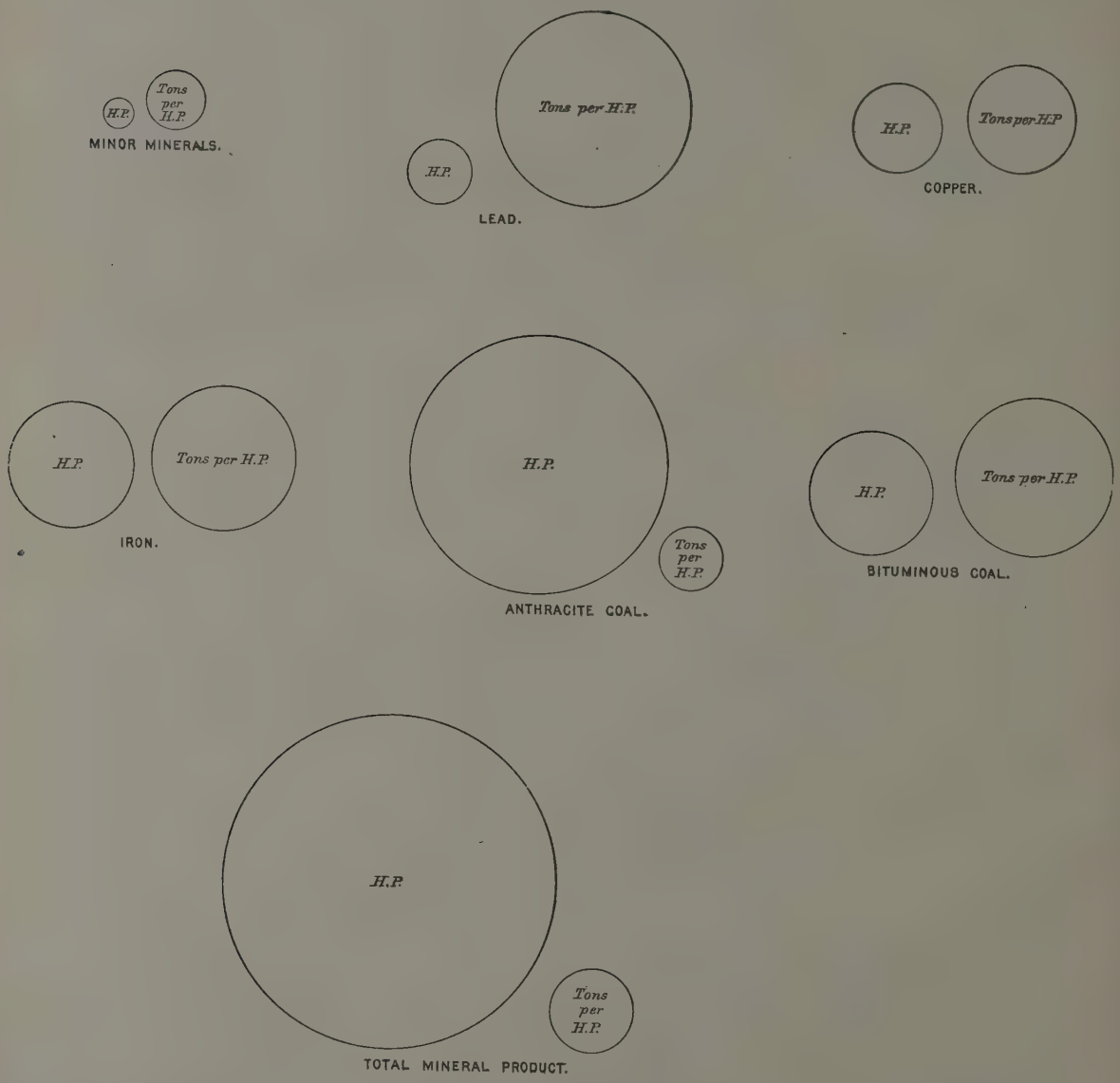
AVERAGE YEARLY WAGES PER HAND.
Shrinkage 29.3%



PRICE OF AVERAGE YEARLY PRODUCT PER HAND.
Shrinkage 24.3%

PLATE VI.—REPRESENTATION OF THE RELATION OF MECHANICAL POWER TO PRODUCT IN THE MINING INDUSTRIES.

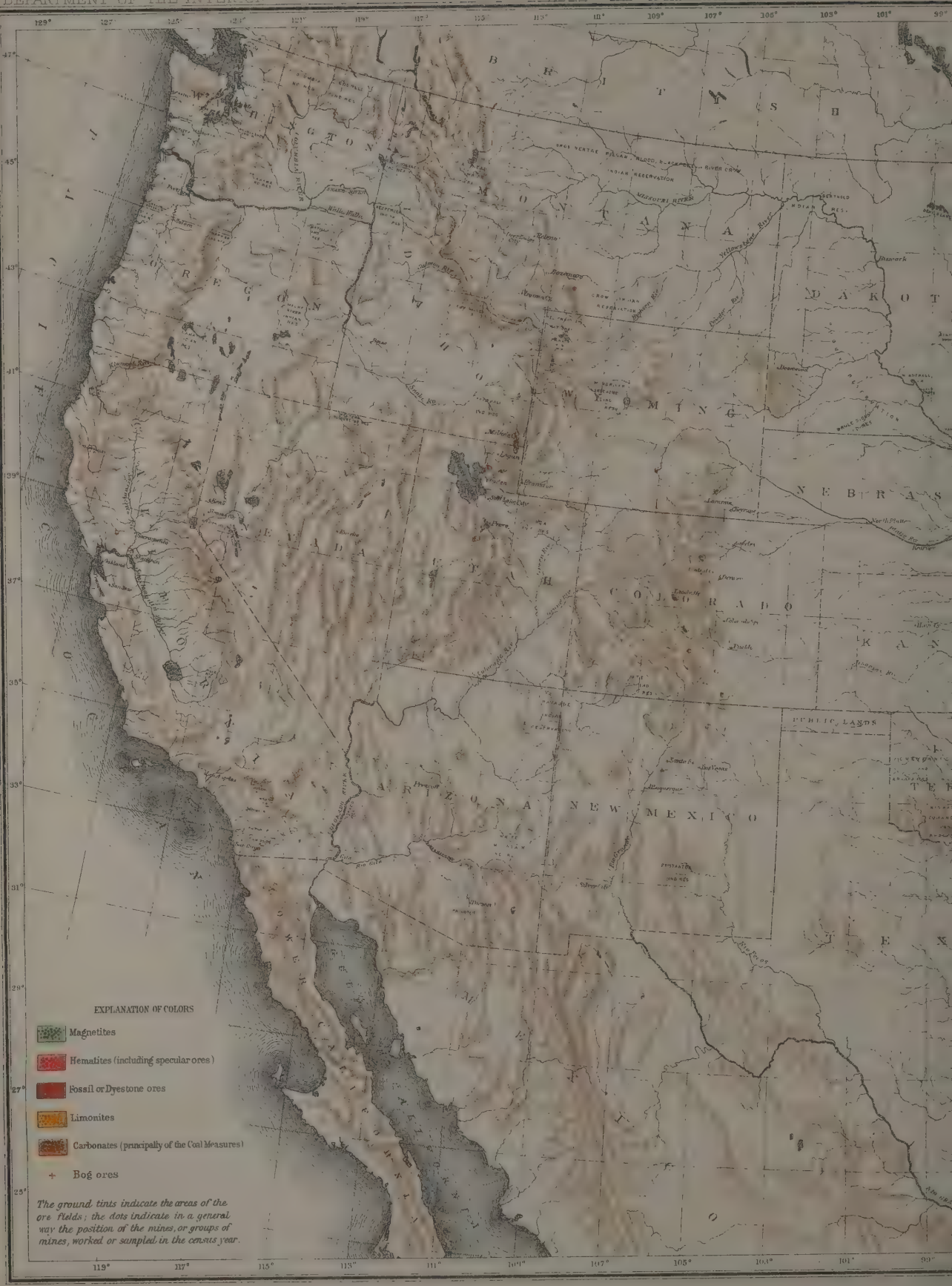
The areas of the left-hand circles represent the engine horse-power employed. The areas of the right-hand circles represent the number of thousand tons raised yearly from the earth per horse-power. In the copper and anthracite-coal mining, however, the power is employed in preparing for market as well as in raising to the surface.



THE IRON ORES

OF THE

UNITED STATES.


EXPLANATION OF COLORS
Magnetites
Hematites (including specular ores)
Fossil or Dyestone ores
Limonites
Carbonates (principally of the Coal Measures)
Bog ores
The ground tints indicate the areas of the ore fields; the dots indicate in a general way the position of the mines, or groups of mines, worked or sampled in the census year.
MONTANA
OREGON
NEVADA
UTAH
COLORADO
ARIZONA
NEW MEXICO
WYOMING
NEBRASKA
PUBLIC LANDS
INDIAN RESERVATION
CROW INDIAN RESERVATION
UNITED STATES INDIAN RES.
Portland
Salem
Boise City
Helena
Bozeman
Cheyenne
Denver
Salt Lake City
Santa Fe
Albuquerque
Silver City
Tucson
Prescott
Yuma
Los Angeles
San Diego
Sacramento
San Francisco
Bismarck
Deadwood
Lincoln
Omaha
Pueblo
Durango
Gunnison
Leadville
Ouray
Silverton
Ft. Bridger
Rawlins
Lander
Cody
Miles City
Glendive
Fort Benton
Ft. Keogh
Ft. Custer
Ft. Shaw
Ft. Ellis
Ft. Peck
Ft. Buford
Ft. Stevenson
Ft. Yates
Ft. Sully
Ft. Pierre
Ft. Randall
Ft. Niobrara
Ft. Robinson
Ft. Sidney
Ft. Lyon
Ft. Garland
Ft. Lewis
Ft. Wingate
Ft. Stanton
Ft. Sumner
Ft. Bliss
Ft. Hancock
Ft. Clark
Ft. Duncan
Ft. Grant
Ft. Bowie
Ft. Yuma
Ft. Mohave
Ft. Tejon
Ft. Point
Ft. Mason
Ft. Ross
Ft. Vancouver
Ft. Walla Walla
Ft. Colville
Ft. Simcoe
Ft. Klamath
Ft. Hall
Ft. Lemhi
Ft. Sheridan
Ft. Keogh
Ft. Custer
Ft. Shaw
Ft. Ellis
Ft. Peck
Ft. Buford
Ft. Stevenson
Ft. Yates
Ft. Sully
Ft. Pierre
Ft. Randall
Ft. Niobrara
Ft. Robinson
Ft. Sidney
Ft. Lyon
Ft. Garland
Ft. Lewis
Ft. Wingate
Ft. Stanton
Ft. Sumner
Ft. Bliss
Ft. Hancock
Ft. Clark
Ft. Duncan
Ft. Grant
Ft. Bowie
Ft. Yuma
Ft. Mohave
Ft. Tejon
Ft. Point
Ft. Mason
Ft. Ross
Ft. Vancouver
Ft. Walla Walla
Ft. Colville
Ft. Simcoe
Ft. Klamath
Ft. Hall
Ft. Lemhi
Ft. Sheridan
Ft. Keogh
Ft. Custer
Ft. Shaw
Ft. Ellis
Ft. Peck
Ft. Buford
Ft. Stevenson
Ft. Yates
Ft. Sully
Ft. Pierre
Ft. Randall
Ft. Niobrara
Ft. Robinson
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Ft. Lyon
Ft. Garland
Ft. Lewis
Ft. Wingate
Ft. Stanton
Ft. Sumner
Ft. Bliss
Ft. Hancock
Ft. Clark
Ft. Duncan
Ft. Grant
Ft. Bowie
Ft. Yuma
Ft. Mohave
Ft. Tejon
Ft. Point
Ft. Mason
Ft. Ross
Ft. Vancouver
Ft. Walla Walla
Ft. Colville
Ft. Simcoe
Ft. Klamath
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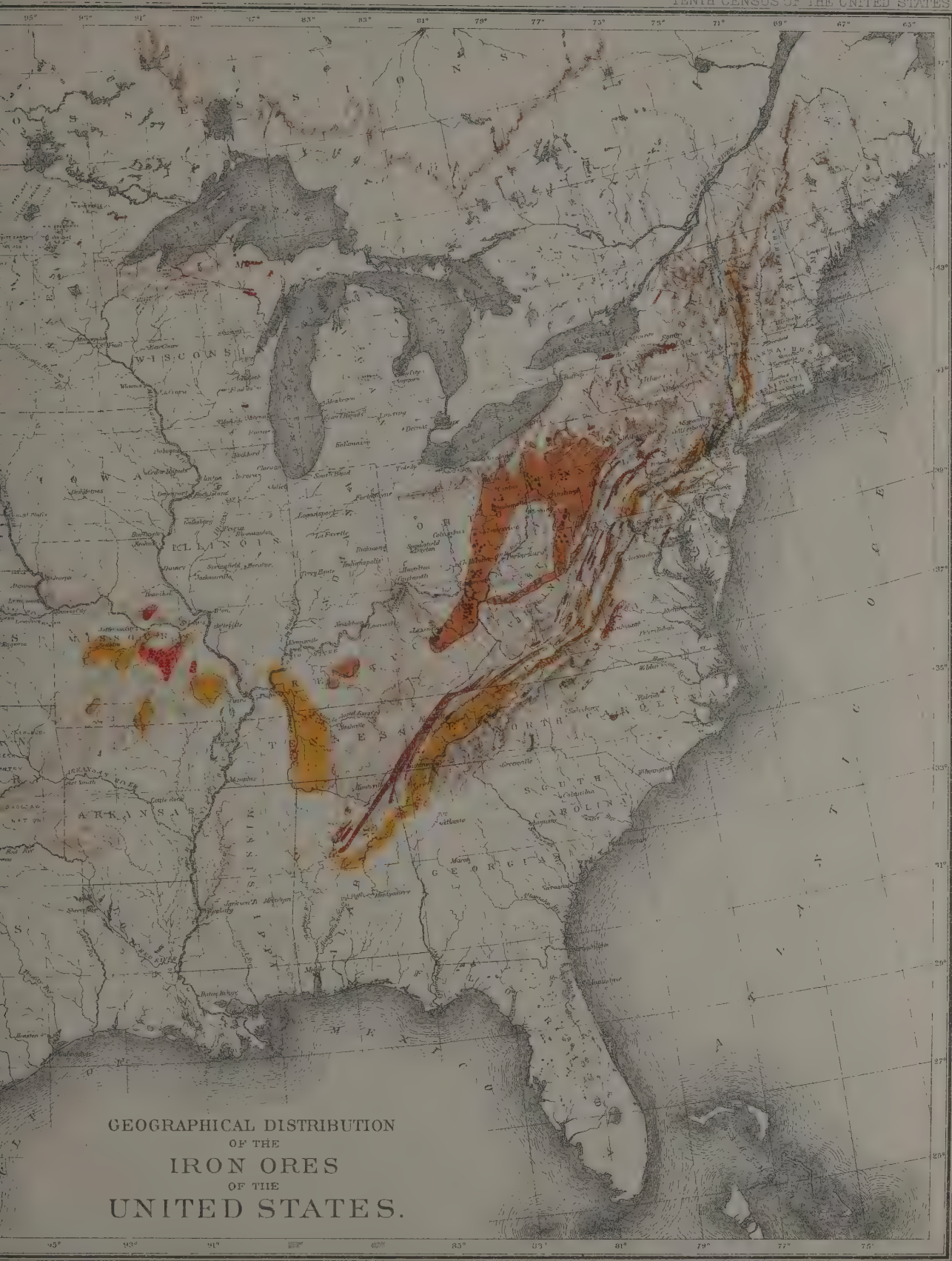
Ft. Lemhi
Ft. Sheridan


GEOGRAPHICAL DISTRIBUTION
OF THE
IRON ORES
OF THE
UNITED STATES.
WISCONSIN
IOWA
ILLINOIS
MISSOURI
ARKANSAS
TENNESSEE
GEORGIA
NORTH CAROLINA
SOUTH CAROLINA
Detroit
Toledo
Cleveland
Pittsburgh
Philadelphia
Baltimore
Washington
Richmond
Raleigh
Charleston
Savannah
Atlanta
Nashville
Memphis
Little Rock
St. Louis
Chicago
Milwaukee
Madison
Dubuque
Davenport
Quincy
Springfield
Indianapolis
Columbus
Lexington
Louisville
Cincinnati
Knoxville
Chattanooga
Mobile
Montgomery
Galveston
Houston
Vicksburg
Natchez
Jackson
Wilmington
Norfolk
Boston
Hartford
Albany
Buffalo
Rochester
Syracuse
Scranton
Harrisburg
Wheeling
Charleston
Frankfort
Jefferson City
Des Moines
Cedar Rapids
Milwaukee
Green Bay
Marquette
Duluth
Ashland
Hancock
Negaunee
Ishpeming
Marquette
Sault Ste Marie
Port Huron
Saginaw
Bay City
Grand Rapids
Muskegon
Kalamazoo
Battle Creek
Lansing
Ann Arbor
Jackson
Flint
Detroit
Toledo
Sandusky
Cleveland
Akron
Canton
Youngstown
Pittsburgh
Altoona
Harrisburg
Lancaster
Reading
Allentown
Scranton
Wilkes-Barre
Pottsville
Hazleton
Easton
Trenton
Camden
Philadelphia
Wilmington
Dover
Baltimore
Annapolis
Washington
Alexandria
Richmond
Petersburg
Norfolk
Newport News
Lynchburg
Roanoke
Bristol
Wheeling
Parkersburg
Charleston
Huntington
Ashland
Frankfort
Louisville
Lexington
Cincinnati
Columbus
Dayton
Springfield
Toledo
Detroit
Lansing
Grand Rapids
Muskegon
Saginaw
Port Huron
Marquette
Ishpeming
Negaunee
Hancock
Ashland
Duluth
Green Bay
Milwaukee
Madison
Dubuque
Davenport
Cedar Rapids
Des Moines
Quincy
Springfield
Indianapolis
Terre Haute
Evansville
Louisville
Nashville
Knoxville
Chattanooga
Atlanta
Augusta
Savannah
Charleston
Columbia
Wilmington
Raleigh
Greensboro
Salisbury
Asheville
Knoxville
Chattanooga
Birmingham
Montgomery
Mobile
Pensacola
Tallahassee
Jacksonville
Vicksburg
Natchez
Jackson
Meridian
Memphis
Little Rock
Hot Springs
Fort Smith
Galveston
Houston
Austin
San Antonio
Corpus Christi
Brownsville
Laredo
Eagle Pass
Del Rio
Sierra Madre
Chihuahua
Durango
Zacatecas
Guadalajara
Mexico
Vera Cruz
Tampico
Matamoros
Monterey
Saltillo
Chihuahua
Hermosillo
Guaymas
Mazatlan
Tepic
Colima
Morelia
Puebla
Oaxaca
Tehuantepec
Campeche
Merida
Tuxtla
Tabasco
Yucatan
Gulf of Mexico
Atlantic Ocean
Pacific Ocean
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Lake Michigan
Lake Superior

GEOGRAPHICAL AND GEOLOGICAL DISTRIBUTION OF THE IRON ORES OF THE UNITED STATES.

By Raphael Pumpelly.

The great coal-field of the central United States is surrounded on the north, east, and south by the uplifted older rocks of the Wisconsin—Michigan, the Appalachian, and the Ozark regions.

This basin and its border contain the fuel and the ore on which and with which the material prosperity of the United States of the twentieth century must be built. It becomes, therefore, of importance to obtain a general survey of the distribution of the various kinds of iron ore both geographically and in the geological column.

On the extreme edge of the border that incloses the coal basin we find in the north and east the Archæan with its immense development of magnetic and specular ores. Next within this and overlying it is the Canadian-Cambrian series, the substructure of the first great longitudinal valley of the Appalachians extending from Canada to Alabama. This valley is not less remarkable for its enormous wealth in limonite ores than for the fertility and durability of its soil. Still farther inward the shales of the Clinton age mark a belt of hematite ore extending from central Alabama to and through eastern New York, and thence westward across the state. The belt thus outlined will be seen, on the map, to have a breadth of from 50 to over 100 miles. Within it, but less persistent in longitudinal representation, are deposits of iron ores occurring—some here some there—in strata of almost every age from the Archæan to the Coal-measures, and the great coal-field thus iron-bound is itself rich in carbonate ores, generally occurring either as clay iron stone, or as black band, or in places as a ferriferous limestone altered to limonite. The map does not attempt to represent the actual distribution of the ores of the Coal-measures, but only the areas within which they were sampled for this investigation.

On the south the Archæan rocks come to the surface only in eastern Missouri, and they here exhibit a great development of magnetic and specular ores. But they occupy only a small area in the broad iron-bearing belt on the map that stretches with a breadth of 100 miles or more northwesterly from Alabama to western Missouri. With the exception of the Missouri Archæan ores this belt consists wholly of later ores, viz, specular and limonite ores of the Cambrian in Missouri, and limonites on the Subcarboniferous limestones of Missouri, Tennessee, and Kentucky.

On the north, far removed from the coal-field, are the extensive and numerous deposits of rich specular and magnetic ores of the Huronian in northern Minnesota and northern Michigan. Farther eastward the northern border is represented beyond our field of investigation by ores of different kinds, but especially Archæan in that part of the territory of the Dominion of Canada lying north of the great lakes.

Iron in various mineral conditions, and especially as an oxide, is among the most widely disseminated of the elements. It is a base with a strong affinity for the acids most frequent in the waters circulating in the upper crust of the earth, viz, carbonic, sulphuric, and the organic, acids. It also has a stronger affinity for oxygen, and in the presence of this it forms the nearly indestructible and—in the ordinary processes of nature—in the absence of organic matter, almost insoluble sesquioxide. As a sesquioxide, in the presence of organic matter, it provides the oxygen for decay, and its residuary protoxide is itself dissolved by the resulting organic acid, and enters into circulation. If the laboratory is a marsh or pond, the iron protosalt is reoxidized at the surface of the water and returns to the bottom as the higher oxide to again part with part of its oxygen and again to be dissolved as a protosalt, and this is continued until the organic matter is consumed; then the iron accumulates on the bottom as a hydrated oxide, or limonite, or "bog-ore".

Rock strata containing organic matter and diffused iron oxide have lived through similar processes, except that the iron, after furnishing its oxygen to the decaying matter and forming a soluble protosalt with the resulting organic acid, has entered into more extended circulation.

The most common solvents of iron in nature are carbonic acid and sulphuric acid; the latter becomes an important agent in moving and concentrating iron, under certain circumstances, as in solfataric action and in the

oxidation of pyritiferous rocks like the Devonian shales of Pennsylvania and Virginia. But doubtless carbonic acid is the most general agent. Besides arising from the oxidation of organic matter confined in sedimentary strata, it enters the earth as an accessory of rain-water, and more is taken up by the water from the decaying vegetable mold; it is also liberated in depth from limestone by the action of chemical processes and enters the ascending currents. However formed, it becomes an accessory constituent of the water that permeates the rocks, and, alone or in connection with other agents, it decomposes the silicates and carries off the iron as a bicarbonate. It follows the channels of flow until it reaches an arresting cause. One such arresting cause, of ultimately great economic importance, is the carbonate of lime in limestones and dolomites and calcareous sandstones resulting in the replacement of lime by iron; another, of equal importance, is oxygen, whether at the surface, where the soluble iron protosalt emerging in spring-water is oxidized to a limonite, or in caverns or small cavities, where it is oxidized and, parting with its acid, is deposited in successive thin films to form stalactitic and mammillary masses of hydrated sesquioxide; therefore, when we consider the general diffusion of iron in both detrital and crystalline rocks, in all sediments and all eruptions, and its remarkable reciprocating relation in the most common and essential processes of nature, it is not strange that we should find it represented by local accumulations in the rocks of every geological age.

How unequal, from an economic point of view, the geological and geographical distribution of concentrated deposits is, will appear from the following review, and from the columnar chart, and from the statistical tables accompanying this chapter:

The survey of the ore-producing field of the United States gives us a pretty good knowledge of the areas within which future discoveries are to be expected. The great wave of activity in the industry in 1880 and 1881 caused a very energetic exploration throughout the old fields and into new ones. This resulted in very few discoveries in the already producing districts. It was made clear that to find new deposits exploration has to go into new fields On Lake Superior the Gogebic district in Michigan, and the Vermillion district in Minnesota, already known to contain iron, were actively explored, and railroads are now built into them. The same cause led to the development of new fields in the southeastern states.

But the growth of the iron industry, notwithstanding its fluctuations as a whole, is making an enormous drain upon the productive deposits of ores of certain classes, such as ores of higher grades in iron percentage, Bessemer ores, etc.

The producing capacity of mines is enlarged to meet the demand and to diminish the cost per ton; small deposits become exhausted; the end of medium-sized ones becomes evident, and with the really great ones, which are also really few in number, it is only a question of years. To satisfy the demands, growing larger every decade for these ores, new fields will need to be found. In a general way we can outline these for the eastern half of the United States. Extensive stretches of the Archæan highlands, especially in Pennsylvania and North Carolina, promise discoveries if subjected to careful magnetic surveys, and the same may be said of the Adirondacks. The Archæan areas north and south of Lake Superior are unquestionably the great fields of future discovery. In the Michigan-Wisconsin areas the ore-bearing horizons of the Huronian are known to extend hundreds of miles through the little-explored wilderness as "iron ranges" waiting for the discovery of the richer ore-bodies. This is notably the case in the region through which the lower members of the Huronian extend to connect the Marquette and Menomonee regions. In regard to the ores of Canadian age, doubtless new limonite discoveries will be made in the "valley" in Pennsylvania toward compensating the exhaustion of known bodies. But the future field for ores of this age, especially specular, is in the Ozark region of Missouri and Arkansas. With the fossil ores it is only a question of a few years before the hematites will be exhausted. The world's consumption of iron and steel must increase largely, and the practical exhaustion of accessible rich ores will perhaps be compassed within the life of the present generation. We shall have then to fall back upon the leaner ores, that is, largely upon the siliceous-specular and siliceous-magnetic ores, ranging between 30 per cent. and 45 per cent. in iron. Of these there are vast quantities, though generally remote from metallurgical coal, and especially in the Huronian of the Lake Superior iron regions. At present in the east the magnetites smelted probably do not average above 50 per cent. in iron, while in Michigan and Missouri they average not less than 60 per cent.

That lower grades of these hard ores find their way to market is shown by the fact that in the census year there were mined in Pennsylvania, New Jersey, and New York, 336,767 tons of magnetite, more or less siliceous, carrying below 45 per cent. iron. There were also mined, chiefly in Pennsylvania, 697,283 tons of limonite, mostly aluminous, carrying less than 40 per cent. iron.

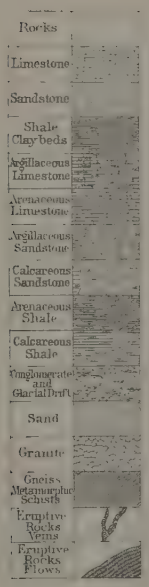
Geologically speaking, the lowest iron ores are included in the Archæan rocks, and of such occurrences we have a number of fields. The great highland range of mountains that now forms the eastern bulwark of our continent, as it probably once formed the western maritime range of a Palæozoic Atlantis, is stored with bodies of magnetite from New England to Georgia. Between lakes Ontario and Champlain lies an important Archæan region, with a variety of magnetic ores.

On the northwestern and southern shores of Lake Superior the upper member of the Archæan contains numerous and immense deposits of both specular and magnetic ores.

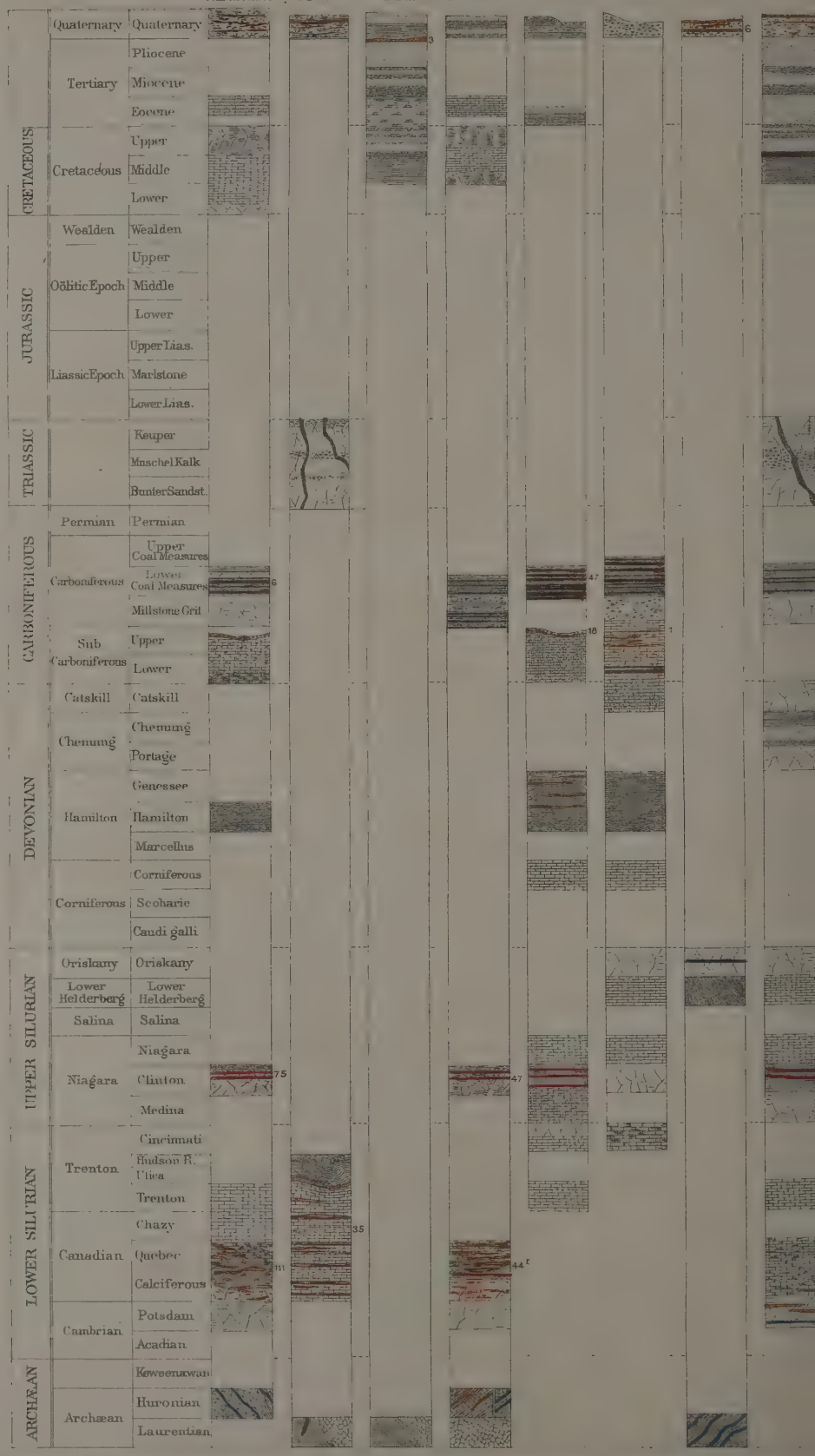
GEOLOGICAL DISTRIBUTION OF THE IRON ORES OF THE UNITED STATES.

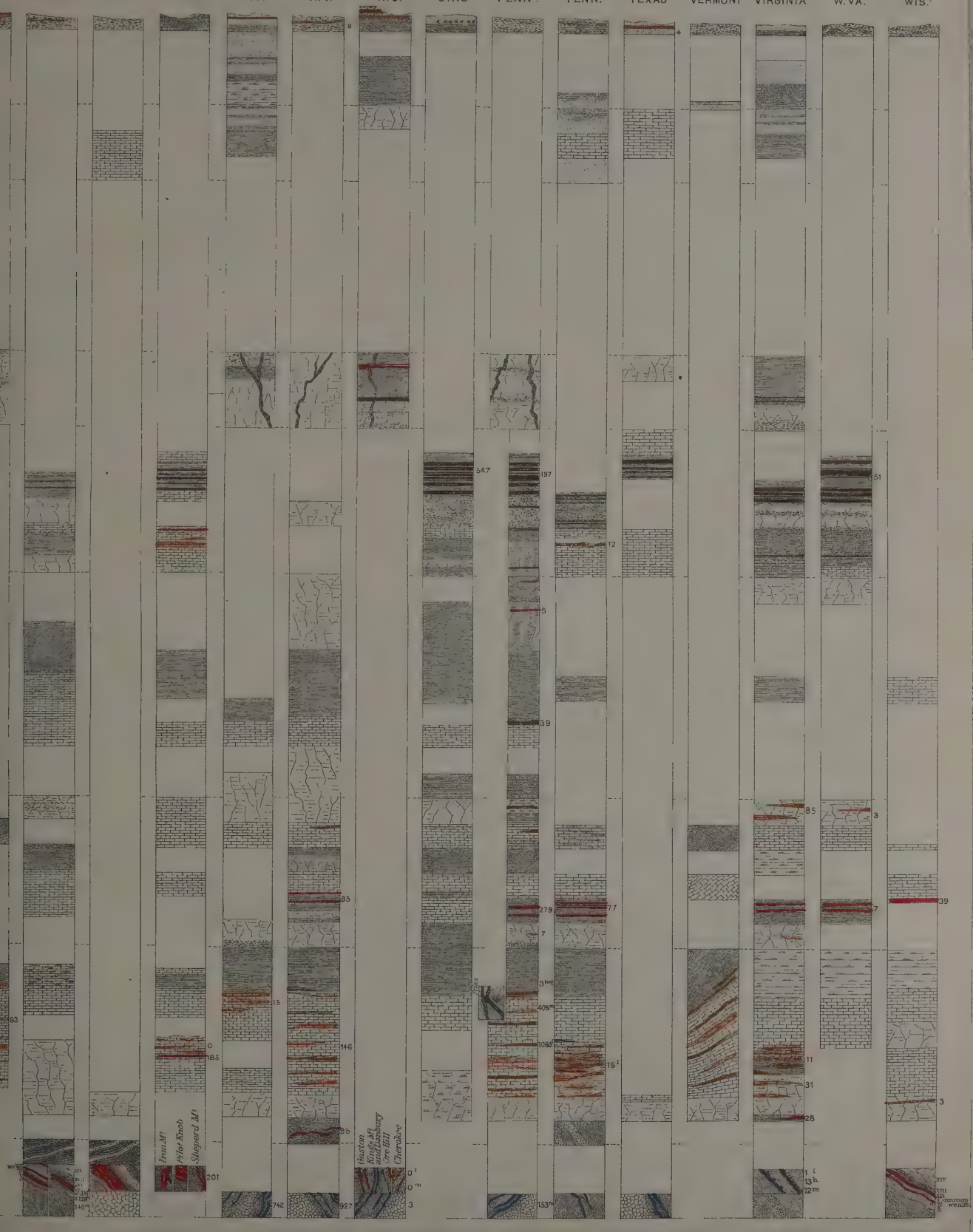
Compiled chiefly from the State Geological Surveys.

The Figures on the right of the columns indicate the number of thousands of tons of ore mined from the horizons near which they are placed in the Census year. Where several kinds of ore were produced from one horizon, the tonnage of each kind is indicated by the use of exponential letters as follows: l. denotes limonite, m. magnetite, h. hematite and c. carbonate.



Magnetite
Hematite
Limonite
Carbonates and derivatives





Julius Bien & Co. Lith.

The fourth Archæan region east of the Rocky mountains, that of Missouri, is very limited in comparison with the two already mentioned, but it also contains several great ore-bodies. Farther west, ore-deposits of various kinds are known at several points in the Archæan of the Cordilleras. Each of the eastern Archæan fields is

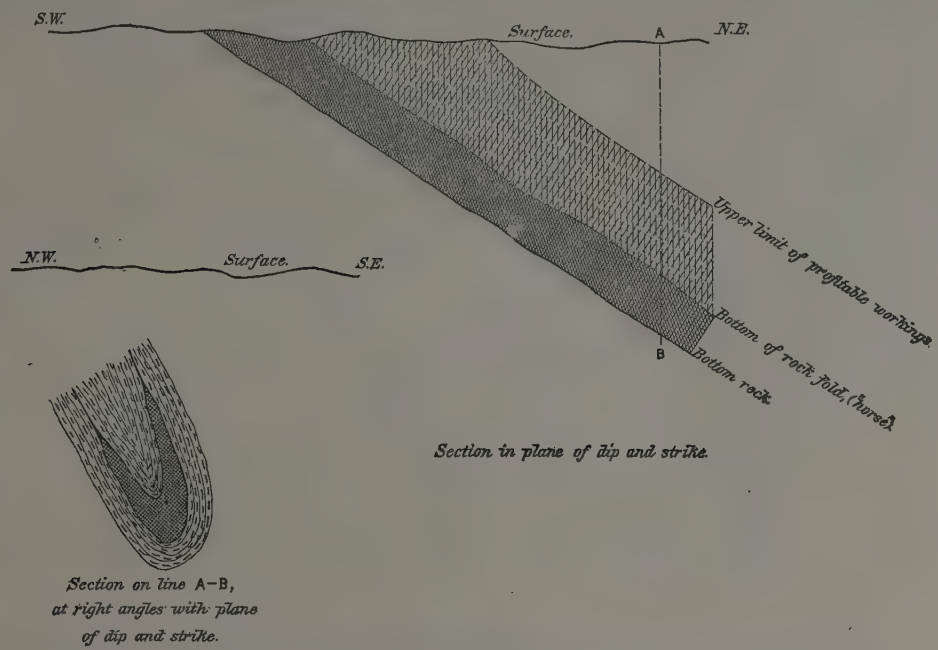


FIG. 1.—SKETCHES TO ILLUSTRATE A COMPRESSED PITCHING SYNCLINAL OF MAGNETIC ORE.

stamped with a marked individuality, not only in its structure and lithological constitution, but also in the habit of its ore occurrences. The eastern Highland range consists of Laurentian gneisses, syenitic and granitic rocks and limestones, and its ores are almost exclusively magnetites. The Adirondack-Champlain region consists of Laurentian gneisses, differently arranged structurally from the Highland range. The Lake Superior ores are specular and magnetic ores bedded in the schists of the Huronian; and the Missouri-Archæan ores are both specular and magnetic, and the alteration product of the latter—martite, and they occur exclusively associated with porphyries and clastic porphyry rocks, supposed to be of Huronian age. And parallel with these differences go fundamental differences in the forms of deposits and character of ores. In the Highland range the rocks are stratiform and tilted, striking northeast and southwest, and dipping steeply to the southeast. They form a belt from 10 to 20 miles wide. They consist in New Jersey and New York chiefly of hornblendic gneiss or syenite granite, and crystalline limestone. According to Mr. Smock, of the geological survey of New Jersey, and a special agent in the statistical part of our census work, these gneisses are rarely free from magnetite, and are often sufficiently impregnated with it to form immense beds of lean ore, and in places workable deposits.

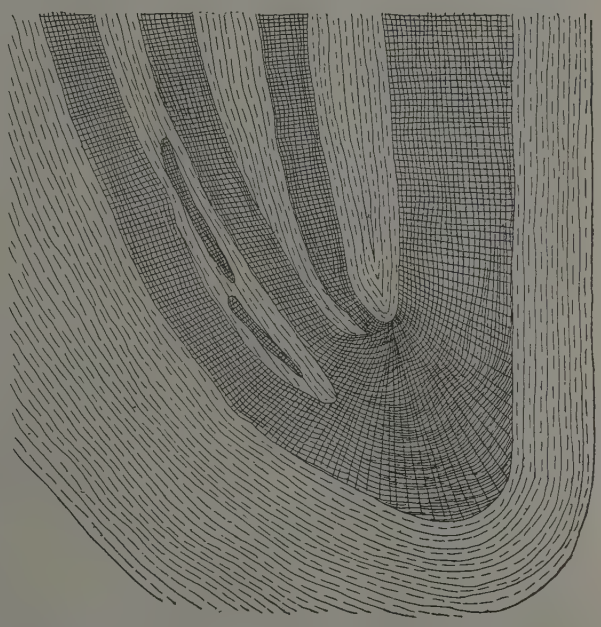


FIG. 2.—SECTION AT THE HURD MINE, MORRIS COUNTY, NEW JERSEY. From *Geology of New Jersey*, 1868.

Magnetite ore-bodies also occur occasionally in the crystalline limestone.

As stated in Mr. Putnam's report, in many of the mines there is no sharp plane of demarkation between the ore and the wall rock, the ore and the gneiss both carrying the same minerals in inverse proportions. In going from the center of an ore-body outward the gneiss minerals increase as the ore diminishes, the limit of the ore-body

being that at which the ore becomes unprofitably lean. In other mines the demarkation is sharply indicated by a smooth wall. A marked peculiarity of the ore-bodies of this highland range is in their structural forms. As will be seen by referring to Mr. Putnam's report, or to the publications of the Geological Survey of New Jersey, there are two well-defined forms: (1) The narrow synclinal, in which the relatively narrow and thin ore-body occupies the bottom of a synclinal fold (Figs. 1 and 2). (2) The "pinch and shoot". In this the single "shoot" is a pod-shaped body, thick along its longitudinal axis, but growing rapidly thinner toward its edges. Several of these are often close together in the same plane of stratification and connected by a thin stratum of ore, a "pinch". (Fig. 3).

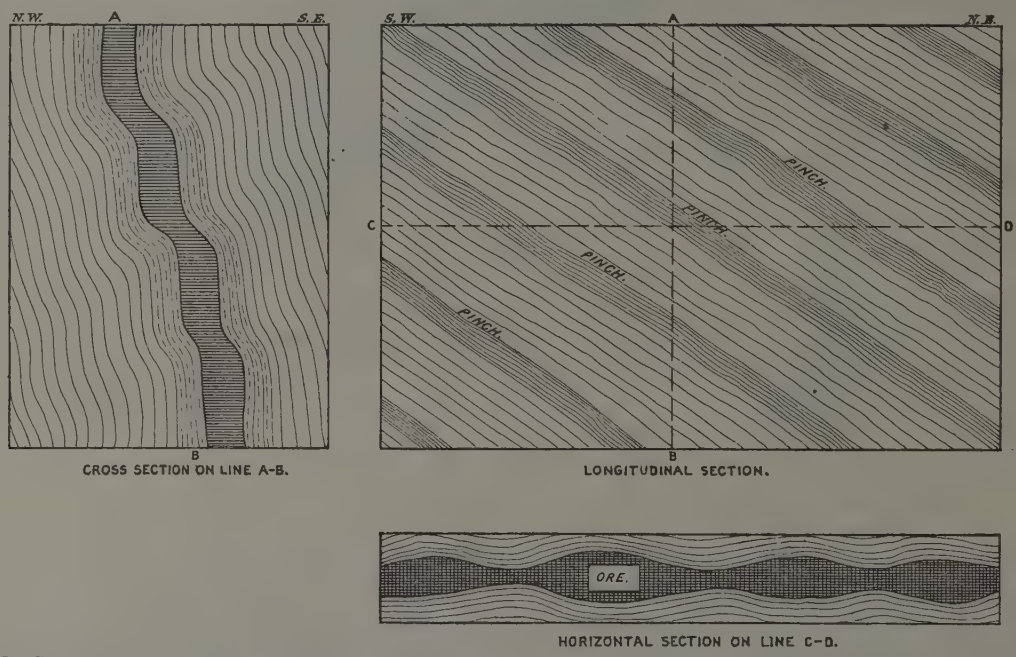


FIG. 3.—SKETCHES TO ILLUSTRATE THE "PINCH AND SHOOT" STRUCTURE OF SOME OF THE NEW JERSEY MAGNETIC ORE DEPOSITS.

NOTE.—The vein of ore is generally relatively much thinner at the pinches than is indicated in the "cross-section on line A–B". The ore is sometimes entirely "cut out" by the walls coming together.

In both of these the ore-body is of great and unknown length compared with its breadth, which is rarely over 100 feet, and its thickness, which is seldom more than 80 feet, and more commonly less than 30; in both the axial plane of the body is in the plane of stratification, and in both the longest axis is inclined, generally to the northeast. This inclination is called "pitch". The ore forms thus either a long, trough-shaped body, or a pod-shaped body, as the case may be, lying conformable to the bedding, but pitching in a direction between the strike and the dip of the gneiss. The ores are associated with quartz, hornblende, feldspar, and apatite. They range from 28 per cent. to 66 per cent. in iron and in phosphorus ratio from 0 to 3.65. But as a matter of fact the Bessemer ore mined in New Jersey contained less than 45 per cent. of iron and was produced by only a few mines.

This Archæan range passing out of New Jersey carries its ore-bearing habit with it into Pennsylvania, where it is known as the South mountain. It has not been as extensively explored for iron ore as in New Jersey and New York, but the ores occur in a similar manner, although they have a remarkably lower phosphorus ratio, bringing many of them within the Bessemer limit. This may be due to the fact that, unlike most of the New Jersey mines, these are south of the region of glaciation, and the opened portions of the deposits may be still within the zone that has been exposed to the action of solvents during geological ages, an action which generally diminishes largely the phosphorus ratio. As we go farther south along the Archæan range we find that the ore-bodies of this age have generally not been worked sufficiently to show fully their extent and frequency, nor their forms.

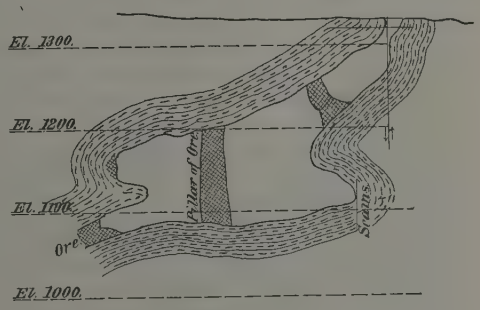
In Virginia the Archæan ores have been mined to some extent on the James river below Lynchburg, and farther to the southwest. The beds containing these ores are considered by Rogers to be probably of Huronian age. The ores are magnetite more or less altered to martite, and specular ore. The foot-wall is talcose or hydro mica-schist, and the hanging-wall a quartzite; and as a rule the specular lies next the schist, and the magnetic next or in the quartzite. This series of relations corresponds perfectly in kind and in order of succession with that of the rocks, fresh ores, and martite of the Marquette district of Lake Superior. The ore-lenses vary from 1 to 15 feet in thickness. In iron they range as mined from about 36 per cent. to 60 per cent., and they are very variable in phosphorus, of which the ratios range from 0.034 to 0.472. Hydrated ores in close proximity to these and contained in the schists have a high phosphorus ratio.

Passing into North Carolina, we find the range of Kerr's Lower Laurentian of western central North Carolina containing titaniferous magnetites in lenticular bodies. The Tuscarora and the Dannemora are the representatives of this class; they have very low phosphorus ratios, but carry considerable titanic acid. In the high range, near the Tennessee border, the gneisses of the Upper Laurentian carry deposits of magnetite, of which the Cranberry and Big Rock Creek mines are examples. Like the New Jersey deposits, these ores are mixed with silicates, pyroxene (instead of hornblende), epidote, etc. The phosphorus ratios of these ores are very low, 0.006 to 0.037. Certain mica-schists, near Danbury, sufficiently impregnated with magnetite to be profitably mined, and becoming charged with pyrites below water-level, are assigned by Kerr to the Upper Laurentian. Our samples gave a phosphorus ratio above the Bessemer limit, but the analyses of the washed ore show that washing lowers the phosphorus ratio to well within that limit. Magnetite occurs in lenticular masses and in workable impregnated beds in the group of schists—mica, chlorite, talcose, and itacolumnite—of western North Carolina, which are assigned by Kerr to the Huronian. They have a very low phosphorus ratio—0.002 to 0.075. Stratified specular ore occurs in the Huronian schists of central North Carolina. At Buckhorn it was worked with a local thickness of 36 feet, associated with manganese and garnet rock. These ores were found to be low in iron, and to contain some titanium, but they have a low phosphorus ratio, 0.043 to 0.070.

One of the most important among the ore-bearing Archæan fields is that of northern New York. It belongs, structurally, to the great Canadian nucleal area, and is separated from the Appalachian Laurentian formation by the Paleozoic rocks of eastern New York. It is pre-eminently a region of Laurentian gneisses, and in these occur some of the most extensive as well as most complicated ore-bodies on the continent. The forms of the ore-bodies are interstratified, irregular lenses, in places forming several parallel beds, and lying in simple monoclinals; at others, squeezed into the pinch and shoot form, so common in New Jersey, or, again, enormously thickened in the enlarged bends of corrugated folds, as at Mineville. Many of the ore-bodies are, like those of New Jersey, largely mixed with the minerals of the adjoining rocks, quartz, feldspar, hornblende, and in places an excess of apatite.

They are easily classified into (1) ores high in phosphorus and low in sulphur; (2) ores low in both phosphorus and sulphur; (3) pyritiferous ore usually low in phosphorus; (4) titaniferous ore.

According to Mr. C. E. Hall, the non-titaniferous iron ores belong in the Lower Laurentian, and these divide again into an upper horizon with ores low in phosphorus, and a lower highly phosphatic horizon of ore. The titaniferous ores he assigns to the Upper Laurentian. Where ore-bodies rich in phosphorus occur near others much freer from this impurity, the latter are seen to occupy a higher horizon, as in the Mineville group, where the New Bed, Barton Hill, and Fisher Hill mines, belonging higher in the gneisses, are low in iron, 39 to 50 per cent., and contain abundantly intermixed quartz, but have a very low phosphorus ratio, 0.005 to 0.096. These ores are frequently enriched by separation to over 60 per cent. iron, for use in the local forges. On the other hand, the lower horizon, exemplified by the "Old Bed" and "Mine 21", contains immense bodies of ore of very complicated structure. The enormous size of the ore bodies is ascribed by Mr. B. T. Putnam, with much soundness of reasoning, to the spreading apart of the strata in an **S** fold, and in support of his view he presents very instructive sections. One of these sections is annexed (Fig. 4).



SECTION THROUGH MILLER PIT.
MINEVILLE, NEW YORK.

FIG. 4.

"Old Bed" and "Mine 21", practically one mine, shipped together in the census year 395,864 tons, and their total product was then estimated to have been 3,584,000 tons. The ores of this lower horizon are higher in iron, ranging between 57 and 67 per cent. They have also a very high phosphorus ratio, ranging between 0.689 and 2.428. The ores of this horizon owe their phosphorus clearly to the presence of an unusual amount of apatite, this mineral being in places so abundant in the ore as to have been mined for its own sake.

South of Lake Superior there is a great Archæan area, extending from the lake southward into Wisconsin, and flanked on the east by the Paleozoic rocks of the Michigan basin, and on the west partly by the Lower Silurian sandstone and partly by the older copper-bearing rocks of the Keweenawan. The central part of this area is chiefly a region of gneisses, with hornblende schists, which by Foster and Whitney were assigned to the Archæan, and later, by Major Brooks, Professor Irving, Credner, and myself have been provisionally considered Laurentian. Lying unconformably on this is the great series of schists which occupy most of the area, and are considered by the same geologists to be Huronian. This upper series is the great iron-bearing member of the Archæan. At or near its base is a heavy quartzite. While the iron series occurs uniformly in the lower part of the Huronian, its structure and character varies in different places. In the Negaunee district it consists of a lower and an upper series. The lower is made up of flag-ores, silicious and ferruginous schists, and some argillaceous and talcose slates and anthophyllitic schists and beds of diabase. The ores of this lower series contain less than 50 per cent. of iron, except where the quartz has been removed and its place taken by rich limonite.

The upper series, which is separated from the lower by a bed of diabase, and a thinner bed of chloritic and talcose slate, contains the rich ores. It consists of a thick mass of banded iron and "jasper", the iron-ore being pure and the jasper generally colored red; and this relation and purity is retained throughout and forms an essential characteristic of the upper series. In places the jasper layers disappear, leaving extensive beds of pure ore; in others the ore gives way to the jasper. In places subsequent chemical action has removed portions of the jasper, while the space thus formed has been filled with limonite in large quantities, as at the Lake Superior mine. The upper part of this upper series has generally a bed of talcose slate, in which the fissile cleavage is wholly independent of the bedding, and which is impregnated with small octahedra of martite. The ore in contact with this slate has the same structure and is impregnated with similar crystals of martite. The upper portion of the upper series consists of beds of rich ore, often granular martite, with talcose schists and very talcose quartzites.

In the western part of Marquette county the ore series occupies the same geological position and exhibits a similar structure, but the ore is to a great extent magnetic, though it is accompanied by more or less important beds of specular ore. The relation between the two varieties appears to be such as would arise from an increased development, toward the west, of the uppermost beds of the upper series of Negaunee, where, as we have seen, there are granular martites which once were magnetites. Just beneath the magnetic beds occurs the banded formation of specular ore and jasper, identical in character with that of the Negaunee district. At several of the mines the disappearance of the jasper layers leaves great workable masses of *pure* specular ore, as at the Republic mine, where the specular predominates over the magnetic.

At this, the western end of the Marquette county ore-field, the basin is narrowed to a width of 2 miles before opening out to form the broad Huronian area of the central part of the Upper Peninsula. The northern edge of the basin is formed by the iron series which, extending along the northern shore of Lake Michigamme, contains the great magnetic deposits of the Michigamme and Spurr Mountain mines. The iron series of the southern edge, containing the Washington, Edwards, Keystone, and Champion magnetic mines bends southwest, forming the southern shore of the lake, and then, with a sharp turn to the southeast, it forms a trough 7 miles long and less than 1 mile wide. In the loop, at the southeastern end, the entire lower and upper series are beautifully represented, culminating in the extensive beds of both specular and magnetic ores of the Republic mine.

It will be seen by reference to table 8 and to the tables of analyses that the mines of the Marquette-Michigamme region shipped 1,346,365 tons of ore ranging from 69 per cent. to 41½ per cent. in iron, with phosphorus ratios ranging from 0.306 to 0.014.

The iron-bearing horizon of the Huronian sweeps from the western end of the Marquette-Michigamme region southward through a little-explored country to the Menomonee region, where it forms several great ranges, only one of which has been extensively developed as yet.

Here it has two extensively-worked ore-bearing horizons, the lower an immense series, many hundred feet thick, of silicious ores, ranging from 50 per cent. downward in iron, and associated with crystalline limestones and argillaceous and talco-chloritic schists. In this series occur the large beds and lenses of very rich, soft specular ore; some of the mines, as the Chapin and Norway, ranking among the great producers of the continent. The mines in the Menominee region shipped 491,347 tons of ore, ranging in iron contents from 67½ per cent. to 38½ per cent., and in phosphorous ratio 0.285 per cent. to 0.000.

West of the Menominee and Michigamme rivers there is a great area of slate rocks, forming in part the upper member of the Huronian. This upper horizon, consisting of quartzites, argillaceous and garnetiferous chloritic slates, bears extensive deposits of compact specular ore, which are worked on a large scale on the Paint river and on the Wisconsin side of the Menominee river. These ores are considered by Major Brooks to be younger than the upper rich ores of the Marquette district. The mines of this horizon were opening, but had not shipped any ore during the census year. Its opening mines were sampled, and the analyses show that the phosphorus ratio is much too high for Bessemer. The iron in the ore as mined for shipment ranged from 46 to 60 per cent., and the phosphorus ratio from 0.288 to 0.672.

The product of the whole Lake Superior region during the census year may be classified as follows:

BY KINDS OF ORE AND ITS CONTENTS IN METALLIC IRON.

	Tons.
Hematite (including the hard specular ore of the Marquette region and the soft specular ore of the Menomonee region):	
Containing over 60 per cent. of iron	998,813
Containing from 45 to 60 per cent. of iron	360,283
Containing under 45 per cent. of iron	
Total hematite	1,359,096
Magnetite:	
Containing over 60 per cent. of iron	148,719
Containing from 45 to 60 per cent. of iron	
Containing under 45 per cent. of iron	
Total magnetite	148,719

	Tons.
Limonite (*i. e.*, the Negaunee and allied "soft hematites"):	
Containing over 50 per cent. of iron	315,740
Containing from 40 to 50 per cent. of iron	14,157
Containing under 40 per cent. of iron	.....
Total limonite	329,897
Grand total	1,837,712

BY PHOSPHORUS RATIOS (or contents of phosphorus per 100 parts of iron).

[*A partial classification.*]

With phosphorus ratio less than 0.05	187,896
With phosphorus ratio from 0.05 to 0.10	760,693
With phosphorus ratio from 0.10 to 0.35	777,317
With phosphorus ratio from 0.50 to 1.00	8,080
Total ore classified	1,733,986
Total ore unclassified	103,726
Grand total	1,837,712

And by reference to the graphic diagrams, Plates XXIII and XXIV, it will be seen that the Michigan, *i. e.*, the Lake Superior, mines produced nearly one-half of all the Bessemer ore raised in the United States. The Menomonee district alone produced over one-sixth of the whole amount. Further, the Lake Superior mines produced of ore carrying over 60 per cent. iron, 1,147,532 tons, or nearly 56 per cent. of all the ore of this grade mined in the United States; and the ores mined in this region in the census year are estimated to have contained 1,087,600 tons of iron, or 26 per cent. of the iron contained in the entire census year's product of the United States. At the western end of the Upper Peninsula of Michigan another extensive ore-bearing field, discovered by Major Brooks and myself in 1871, has recently been opened at the base of the Huronian. With intervals the ores have been exposed along a line extending from a point about 20 miles west of Lake Gogebic to the Montreal river. This region will begin its shipments in 1885. West of this the same ore-bearing horizon was described about 30 years ago by Colonel Charles Whittlesey, in Ashland county, Wisconsin, and commonly called the Penokie (*a*) range. These ores being undeveloped in the census year were not sampled. They are stated to be high-grade Bessemer ores.

The Archæan mass that rises near the eastern end of the Ozark mountains, in Missouri, consists of areas of granitic rocks, which have been considered to be Laurentian, and of porphyries and porphyry conglomerates, which are probably of Huronian age. The iron ores of Missouri are associated with the porphyries and their conglomerates. Magnetic ores and martite occur in porphyry, in a true vein at Shepherd mountain, with 65½ per cent. iron and 0.020 phosphorus ratio; and in an immense irregular vein or mass, in places 60 feet thick (*b*), in decomposed porphyry, at Iron mountain, where the great ore-body sends countless anastomosing veins of ore abounding in crystals of apatite into the porphyry to form a reticulated mass of ore and rock (Fig. 5). Through the atmospheric removal of the decomposed porphyry, which has been going on probably since the Silurian time, the heavy and indestructible ore-veins have been left to form an accumulating mantle of ore detritus; and thick beds of stratified ore, pebbles, and porphyry-clay, around the base of the mountain, show that the Paleozoic ocean broke upon an already decomposing porphyry mass.

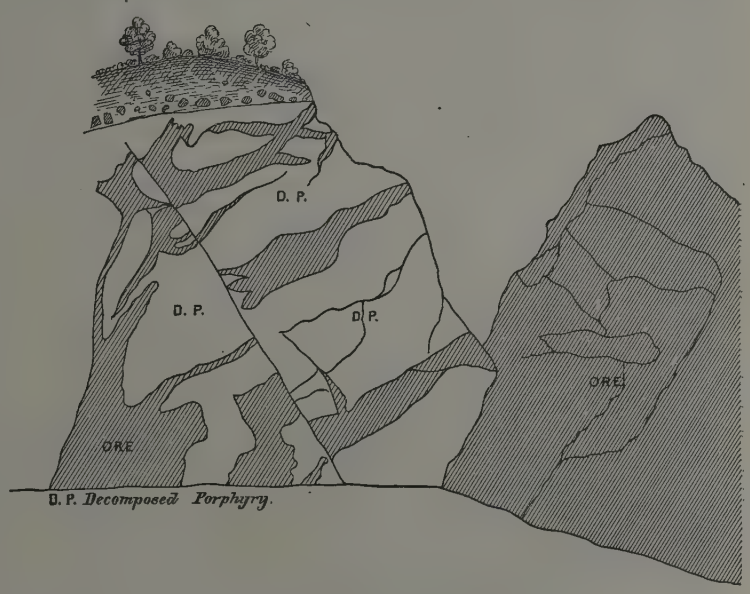


FIG. 5.—SECTION AT IRON MOUNTAIN, MISSOURI. From *Geological Survey of Missouri*, 1872.

The ore of the detritus mantle and of the beds at the base of the mountain has lost nearly all of its phosphorus through the weathering of the apatite crystals.

During the census year the product of Iron mountain was 144,153 tons. Five samples ranged in iron from 59 to 67 per cent., and in phosphorus ratio from 0.008 to 0.674.

a Penokie is an uncorrected typographical error for *Pewabic*, the Chippewa word for iron. *b* In 1872.

Pilot knob is a conical hill rising 662 feet above its base. It is composed of bedded porphyries overlaid by porphyry conglomerates, dipping about 13°. Near the top and beneath the conglomerate the hill is traversed by a conformably stratified bed of specular ore. There are really two beds, separated by a slate seam 1 to 3 feet thick. The lower bed, 25 to 40 feet thick, is largely of high-grade ore—52½ to 59½ per cent. iron in two samples, with phosphorus ratios, respectively, of 0.034 and 0.008. The upper bed is of irregular thickness, rising with a jagged upper surface into numerous points into the conglomerate. This upper bed, 6 to 10 feet or more thick, is leaner than the lower. But the sampling shows that it is susceptible of being sorted to produce an ore of 50 per cent. iron, with a phosphorus ratio of 0.050. At other points in this Archæan area the porphyry contains specular ores in irregular masses of unexplored extent. On Cedar hill such a deposit carries an extremely hard and brittle specular ore, which, however, has 66½ per cent. iron, with a phosphorus ratio of only 0.009. It is rather remarkable that the ores of Iron mountain, Pilot knob, and Shepherd mountain—all in porphyry—should be free from manganese. Highly manganiferous ores occur, however, in places in the porphyries of this region.

Magnetic ore occurs in small seams sometimes over 1 foot thick in gabbro-like rocks of Keweenawan age near Agate bay, on the Minnesota shore of Lake Superior. Mr. Willis' sample gave 51.71 iron, with a phosphorus ratio of 0.052.

An examination of the chart giving the geological distribution of the ores will show how generally iron ore in *workable deposits* is distributed. There is scarcely a geological horizon that is not iron-ore bearing in some part of the United States, or even in the Appalachian region alone. The lowest ores above the Archæan appear to be the hematite deposits in the Cambrian.

In Virginia, where the Potsdam sandstone (No. I) becomes slaty toward the bottom, and graduates into reddish and olive shales toward the top, these upper shales contain deposits of hematite, which is silicious and rather low in iron.

Next in importance to the Archæan magnetites of the Appalachian fields stand the limonites, associated with the Siluro-Cambrian limestones and schists. In the Appalachian region—from northern Vermont to central Alabama—there is a limonite-bearing belt of national importance. It occupies the great valley region that forms the depression between the lofty Archæan chain on the east, and the Upper Silurian ridges that form the corrugated front of the great plateau to the west. This great anticlinal depression represents the position of the Cambrian, Canadian, and Trenton formations. In western New England these rocks are highly metamorphosed, and form, as has been finally demonstrated by Professor Dana, the argillites, hydromica-schists, gneisses, quartzites, and limestones of the Taconic. In the central region—in Pennsylvania—they are the magnesian limestones and interbedded hydromica slates, together constituting Formation II of the Pennsylvania survey and the Canadian of Dana, overlaid by the rocks of the Trenton. In Virginia, Formation II consists of more or less dolomitic limestone, with heavy beds of chert and variegated and more or less calcareous slates.

Farther south, in Tennessee, Formation II is represented by the still less metamorphosed sandstones, shales, and thick dolomites of the Knox group. Throughout the length of this belt limonite ores have been known and worked for more than a century. They occur throughout the limestone areas in deposits of clay that are the residuary or leached outcroppings of beds that are interstratified with the limestones or schists and quartzites. In this clay the ore occurs, as a rule, in small pieces in concretionary, massive, earthy, or botryoidal shape. When hollow, as in the concretionary bomb or pot ore, the inner surface is usually glossy and black from a film of oxide of manganese. As a rule, the fractures of these, as of the other forms, except the earthy variety, show the silky fibrous texture due to crystallization. The bombs, which occasionally contain stalactites of limonite—"pipe-ore"—are filled with soft clay or water. The ore thus scattered through the clay has to be washed to effect a separation from this. I believe this is the general character of the ore throughout this long belt. The deposits vary in extent and in the relative abundance of the ore in the clay. They also vary as regards the nature of the inclosing-walls. In some cases, as at Ore hill, in Connecticut, these are both schists; in others, as at the Clove mine, New York, they are both limestone; in others the ore-body may have limestone on one side and schist or quartzite on the other. In some cases, where the bottom of the ore has been reached, it has been found to rest on limestone, *i. e.*, the ore and clay deposits were found to have occupied the position of that part of an original limestone bed which lay above the drainage-level. Where the walls are of clay this frequently retains the original structure of the schists, to the decomposition of which it owes its origin, and where the schist contained veins of quartz these remain in place.

In some cases, as at the Gridley mine, in New York, "horses" of carbonate of iron occur in the ore deposits, and at least in one case, according to Professor Dana, the carbonate shows a stratification quite conformable to that of the neighboring limestones. These limonite occurrences appear to stand in a close genetic relation to the limestone and the hydromica-schists, for they are not only in close proximity to the limestone beds, but they are, as Professor Dana has shown, generally confined to those portions of the limestone belt in which the hydromica-schists occur, and they avoid those parts where the schists are argillitic instead of hydromicaceous.

I do not propose to discuss the numerous hypotheses that have been advanced to explain the origin of the limonite deposits. The view which seems to be advocated by Professor Dana (*a*) is that these deposits have resulted

a American Journal of Science and Arts, 1877, p. 135.

from the leaching of beds, either of carbonate of iron or of limestone carrying iron carbonates. This view is favored by the close relation of the deposits to the limestones, and by the occurrence within them of masses of carbonate of iron having their surfaces and cracks occupied by limonite as an alteration product. And also by the fact that beds of iron carbonate exist and are mined in the Hudson river slates near the Hudson. But there are many circumstances that seem to point to a more complicated origin.

Mr. Prime states that, in Pennsylvania, some deposits have resulted from the leaching of hydromica-schists and others from that of limestone, and that it is easy to distinguish the one from the other, because the clays derived from the schist are white, while yellow clay is left by the limestone. He says that the ore in the clays residuary to the limestone are much less regular, and are generally associated with fragments of angular chert, and it is here that the pipe-ore occurs chiefly. On the other hand, the pot- and wash-ore occurs most abundantly when associated with the damourite slate or with the clay resulting from it.

In Virginia this formation does not seem to carry as extensive deposits as in Pennsylvania and New England, and the formation itself appears to have suffered less metamorphism. An excellent illustration of the formation of limonite by pseudomorphism in mass, so to speak, from limestone was observed in some Virginian localities by Mr. Benton. In Wythe county the limonite is closely associated with limestone and shales, both of which were assigned by Professor Rogers to his Formation II (Canadian). The derivation of a cavernous limonite from a limestone (*a*) was observed by Mr. Benton at Hurst bank, in Wythe county. Here a thinly-laminated limestone is much broken; the interstices between the laminæ, as well as the cracks crossing them, are filled with hard limonite; in a further stage the fragments of limestone, inclosed in the limonite network, become smaller, softened, and brown; in the most advanced stage the limestone fragments have disappeared, leaving only cavities containing sandy ocher. Thus the final result is a cavernous limonite, with its cavities containing the residuary insoluble impurities of the limestone.

The hydromica-schists seem to be absent, or at least not prominent, in Tennessee, and the descriptions appear to indicate that the deposits are there more of the nature of those derived from the limestone in Pennsylvania. The great Knox group, corresponding to the Calciferous and Quebec (Dana), consists of Knox sandstone overlaid by Knox shales, and this overlaid by Knox dolomites, the shale and dolomite being the Quebec equivalents.

The residuary ridges and knolls of clay and chert left by the leaching of these rocks contain limonite in nodules, which generally contain cores of pyrites when over 1 foot in diameter. The proportion of ore to clay, where mined, varies from equal amounts down to one-tenth and less.

The conditions all seem to point to the action of several causes; to an infiltration of ferrous solutions, and (1st) the segregation of the oxide in the clays in some cases, and (2d) its precipitation in caverns in others; frequently (3d) to the oxidation of pure carbonates, or (4th) the leaching away of lime carbonate from a ferriferous limestone. In the third of these cases the limonite would be a pseudomorph in mass, after the siderite, and would have a stony, not a silky-fibrous, fracture. In the fourth case the tendency would be to leave a loose, friable ore, also without any evidence of integral crystallization. The formation of stalactites of limonite is evidence of the movement of ferrous solutions and crystallization in cavities.

These Lower Silurian limonite deposits yielded during the census year 1,625,823 tons of ore, ranging, as delivered, between 30 and 58 per cent. metallic iron, and in phosphorus ratio between 0.023 and 3.78. It will be observed by inspecting the analyses that quite a number of localities produced ores sufficiently low in phosphorus to be adapted to the manufacture of Bessemer steel.

The average royalty paid was 47.4 cents, the range being from 8.8 cents to $1 78.

At several points in the great valley in Pennsylvania there occur deposits of magnetic ore, some of which are of great size, that at Cornwall being one of the largest of known deposits. They are associated with limestone beds and with green schists, and are traversed by trap-masses and dikes. They have been considered to be eruptive, but the later views and descriptions of Lesley, Hunt, Frazer, and Willis agree as to their non-eruptive character.

Hunt places them in Roger's Primal slates, but identifies these with Emmon's Lower Taconic, and considers them older than the Potsdam. Professor Lesley states, in a communication to me, that he considers these deposits to have been originally members of the great range of brown hematite deposits in the Auroral limestone (II), which have been metamorphosed into magnetites and specular ores by the traps. And he is inclined to place them in the upper part of the great limestone. His exceptional position in regard to the age of these ores is, he states, influenced by the fact that the limestone belt contains numerous synclinals of Utica and Hudson river shales, and that not only the limestone, but also these overlying synclinals of shales are seen going down beneath the Mesozoic formation, and have, as he believes, been mistaken for Primal slates. Professor Lesley's view of the derivation of these ores from the alteration of the brown hematites by the eruptive trap goes also to explain why similar deposits are not found in New Jersey and Virginia, where the conjunction of traps and brown hematite is wanting.

The ores are peculiar in that they contain copper in quantities of some economic importance; also in the frequent presence of cobalt in the associated sulphurets. They are also rather exceptional as magnetites, in that they are very low in phosphorus. Out of twenty-three commercial samples collected by Mr. Willis, in only four

a Unfortunately no analyses were made to show to what extent the limestone was ferriferous, if at all.

did the phosphorus ratio rise to one-tenth of one per cent. If these ores are the alteration products of the brown hematites, which have a phosphorus ratio almost uniformly above one-tenth of one per cent., the partial elimination of this most persistent element has to be accounted for. On the other hand, copper and cobalt occur in the brown hematites of the upper part of the great limestone.

The magnetic ore mines of the Mesozoic sandstone belt in Pennsylvania produced in the census year 402,554 tons of ore, ranging in iron contents from 38 to 60 per cent., and in phosphorus ratio from 0.017 to 0.202.

The only representatives of the ores of Canadian age in the interior of the continent are the very numerous and important deposits in southern Missouri. Here the lower magnesian limestone of Swallow, to a greater or less extent, represents the Canadian. It consists of four magnesian limestones 190 to 350 feet thick, and three interstratified sandstones from 50 to 125 feet thick. In this series, but especially associated with the third sandstone, occur the widespread deposits of specular ores. Many of the ore-bodies are of large size, containing many thousands of tons. The ore is on the sandstone, or separated from it by clay and fragments of chert. It is overlaid by clay, with chert and sandstone fragments. The form of deposit is more or less circular or elliptical in horizontal section.

Throughout this part of southern Missouri the first and second magnesian limestones have disappeared. They have unquestionably been dissolved away by the action of water and carbonic acid operating continuously on a region that seems to have been above the sea since Paleozoic times. The result of this action is visible in the great mantle of residuary clay, chert, and sandstone fragments that cover southern Missouri to a considerable depth.

In the progress of this leaching process the drainage must have been to an enormous extent through subterranean channels. The ore-bodies are overlaid only by residuary clay and chert, and give evidence of considerable disturbance on their outskirts, the otherwise horizontal sandstone strata often bending downward to pass under the ore and forming a circular outcrop around it (Fig. 6).

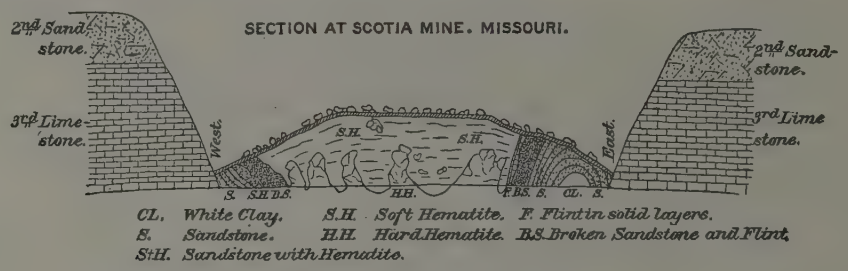


FIG. 6.

With all the variations of occurrence of the ore-bodies of this region, the conditions all seem to me to point to their having been formed in the channels or wells of this downward drainage, through which the surface-waters, carrying the soluble constituents of the formerly overlying limestones of the group, passed into the still lower drainage-channels (caves, etc.) of the underlying limestone; and to the later caving in of the sandstone into these washed-out cavities was due the disturbance on the outskirts of the ore and the tilting of the surrounding sandstone. The ore in these deposits is a hard, compact, bluish, specular variety; this is their normal character. They are associated with soft red hematite and sometimes with limonite, which are considered by Dr. Schmidt(*a*) to be products of alteration of the specular ore. Considering the great extent of country that has been subjected to the leaching process outlined above, it should seem that these deposits of southern Missouri must be very numerous and rank in importance with the limonites of the great Appalachian valley. In the census year there were mined 184,635 tons of ore of this class, ranging in iron contents from 46 to 66 per cent., and in phosphorus ratio from 0.031 to 0.221.

We have seen that the ores associated with the sandstones of the lower magnesian limestone group are specular and red hematite. In the second and third magnesian limestones in southern Missouri there are numerous occurrences of limonite ores. They are found in regular crevices, pockets, and cavities, from the smallest size to very large dimensions, either on or very near the surface of the limestone. The surface of the limestone underneath the ore-bodies is exceedingly irregular, rising into points and sinking into deep holes, and the rock is softened and altered in a way that shows it to have been exposed to the dissolving action of water. The ore itself is stalactitic in structure, and the whole appearance is that of deposits formed in limestone cavities.

Spathic iron ores occur in the great limonite mines in the limestones of Canadian age, either as residuary portions of former more extensive carbonate deposits, or of secondary formation by replacement. This form of ore, which is rather unusual in this country, occurs and is worked on a considerable scale in the slates of Hudson river or Cincinnati age, near the city of Hudson, on the Hudson river. It has been described by Raymond as forming beds 12 to 16 feet thick, resembling a fine-grained, dark-gray silicious limestone. Mr. Putnam's sampling of a stock pile of 2,000 tons at the furnace gave 41.41 per cent. iron, with a phosphorus ratio of 0.384.

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a *Geological Survey of Missouri*, 1873, p. 66.

Next in importance to the Lower Silurian limonites stand the hematite ores of Clinton age—the fossil or **a** dyestone ores.

The persistent occurrence of this ore in this horizon is one of its characteristics; for although it does not occur everywhere in the Clinton, its absence is rather the exception than the rule east of the Mississippi. In New York, beginning at the extreme west, we find it absent at Niagara, where the Clinton is represented by only 4 feet of shale and 25 feet of superincumbent limestone. Going east, already on the Genesee we find 80 feet of Clinton, consisting of two beds of limestone and two of shale, with a bed of ore between the lowest shale and its overlying limestone.

Farther east, in Oneida, Herkimer, and Montgomery counties this group is from 100 to 200 feet thick, consisting essentially of greenish shales; the limestones disappear or are represented only by some calcareous **b** sandstones; and two beds of ore appear, one 2 feet and the other 15 inches thick. Along the Appalachian range the ore of this horizon assumes great economic importance from its proximity to the metallurgical coal and centers of iron manufacture.

In Pennsylvania the length of the line of outcrop is immensely increased by its zigzag winding around the many anticlinal and synclinal folds that corrugate the central part of the state. In this part of the range the Clinton thickens to over 2,000 feet of greenish shales. In these there occur several layers of red ore, some of which are due to the impregnation of sandstone layers, while others are alterations of seams of ferriferous limestone. From 1 to 3 feet appears to be the range of thickness of the workable beds.

The principal ore-beds of the Clinton group, as given for Snyder county by the Second Geological Survey of Pennsylvania, are as follows: **c**

"*Sand vein ore*", the highest, which is a fossiliferous limestone, often nearly destitute of iron, but in places rich enough to yield 20 and even 40 per cent. iron, usually soft along the outcrop and always hard below drainage.

The *Danville ore beds*, a group of fossiliferous limestone beds impregnated with iron and close together. It is rare that any one of them reaches a thickness of 3 feet, and all of them are softened a varying number of yards from the surface down the dip, and in proportion to its gentleness.

The *Block ore-bed*, 1 to 12 feet thick, lies 150 feet lower.

The highly-esteemed *Bird's-eye fossil ore*, 6 to 14 inches thick in the 500 feet of olive shales forming the lower part of the Clinton group.

In Virginia and West Virginia, though less explored, the Clinton ores are known to have locally a much greater development than in Pennsylvania. In the latter state, in Grant, Hardy, and Pendleton counties, they rival the **d** deposits of Alabama, and range from 3 to 30 feet in thickness. In Virginia, while these ores are generally less than 20 inches thick, they thicken in Lee and Wise counties to several feet.

Here should be included the hematite beds, 12 to 18 inches thick, forming part of the grand anticlinal arch at Clifton forge, and belonging, according to W. B. Rogers, to the Medina. In Tennessee, instead of 2,000 feet of Clinton shales, we find from 100 to 300 feet only.

Near the Georgia line a section given by Safford represents 136 feet. It consists of greenish shales with numerous calcareous seams, for the most part thin, several of which are altered to hematite, some of them being workable ore-beds varying from 1½ to 5 feet in thickness. By folding and faulting, the outcrops are reduplicated in parallel ridges, and in places brought into the closest proximity to the coal. The Clinton, passing across the northwestern corner of Georgia and entering Alabama, assumes here again great economic importance. Beds of **e** these ores 7 feet thick were worked during the census year, and later discoveries of much greater size are reported.

At the mines of the Eureka furnace occurs an aggregate of 34 to 37 feet of ore, ranging from 30 to 54 per cent. metallic iron, in three beds, separated by 3 feet and 15 feet of sandstone. Wherever the workings have gone to the drainage-level the ore has been found to give place to a more or less ferruginous limestone. The percentage of metallic iron ranges between 31 and 58 per cent., and the phosphorus ratio from 0.081 to 3.31.

Long-continued exposure seems to eliminate some of the phosphorus, for pieces lying loose in the soil and ore-gravel generally contain less than 0.10 per cent. phosphorus to 100 per cent. of iron. The Clinton is known in the interior of the continent as an iron-bearing horizon, only in Wisconsin, Kentucky, and Ohio. In Wisconsin the well-known mines of Dodge county are worked in one of the finest and most extensive deposits known. Here 14 to 26 feet thickness of ore lies between the Cincinnati shales and the Niagara limestone. In Kentucky the ores of **f** this horizon are represented and were formerly worked in Bath county. The ore is here fossiliferous and more or less hydrated, so that it is rather a limonite. In Ohio it is known in three counties, and has been somewhat, but unsuccessfully, worked, as it is calcareous and apt to be lean.

The Clinton ore deposits have in common:

1st. Association with more or less heavily bedded olive shales, which owe their greenish color to ferrous silicates.

2d. Occurrence of the ore only above drainage-level, and change from ore to more or less ferriferous limestone below that level.

At various points, especially in Pennsylvania, and more particularly in Blair county, extensive deposits of limonite occur in caverns in the Lower Helderberg limestones.

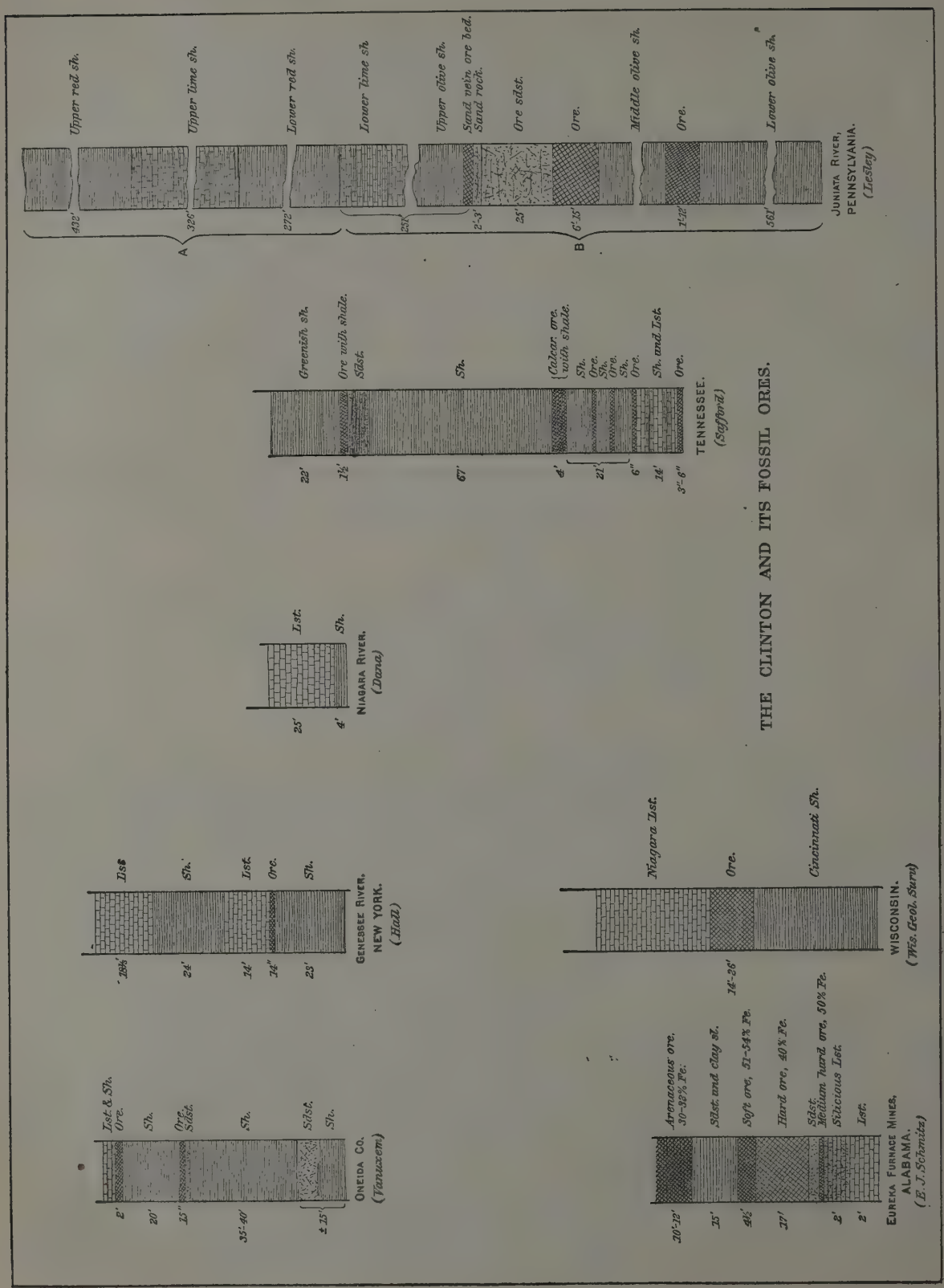

Upper red sh.
Upper lime sh.
Lower red sh.
Lower lime sh.
Upper olive sh.
Sand vein, ore bed.
Sand rock.
Ore sdst.
Ore.
Middle olive sh.
Ore.
Lower olive sh.
A
B
JUNIATA RIVER, PENNSYLVANIA. (Lesley)
Greenish sh.
Ore with shale.
Sdst.
Sh.
(Calcar. ore. with shale.
Sh. Ore. Sh. Ore. Sh. Ore.
Sh. and lst.
Ore.
TENNESSEE. (Safford)
THE CLINTON AND ITS FOSSIL ORES.
lst.
Sh.
NIAGARA RIVER. (Dana)
lst.
Sh.
Ore.
Sh.
GENESEE RIVER, NEW YORK. (Hall)
lst. & Sh.
Ore.
Sh.
Ore.
Sdst.
Sh.
Sdst.
Sh.
ONEIDA CO. (Vanuxem)
Niagara lst.
Ore.
Cincinnati Sh.
WISCONSIN. (Wis. Geol. Surv)
Arenaceous ore, 30-35% Fe.
Sdst. and clay st.
Soft ore, 51-54% Fe.
Hard ore, 40% Fe.
Sdst.
Medium hard ore, 50% Fe.
Siliceous lst.
lst.
EUREKA FURNACE MINES, ALABAMA. (E. J. Schmitz)

FIG. 7.

The next iron-ore bearing horizon is the Oriskany, as developed in the middle Appalachians. In Pennsylvania a local deposits of more or less silicious limonite occur in this sandstone in the middle and at the top, and also in its associated shales. But the greatest development of Oriskany ores is in Virginia. They occur at numerous points, and are best represented in the mines of the old Dolly Ann furnace, and at Longdale, on Brushy mountain, and again at Lowmoor. At these places the ore varies from 10 to 30 and even 40 feet in thickness, and is separated from the sandstone by beds of stiff clay. These Oriskany limonites differ from those of the Siluro-Cambrian deposits in being silicious, while the latter are aluminous. The ore-bearing character of the Oriskany appears to be best developed where it is immediately overlaid by the shales of the Hamilton period, where, as in Virginia, the rocks of the Corniferous period are absent. The ore ranges from 32 to 52 per cent. metallic iron, and from 0.075 to 2.331 per cent. phosphorus ratio. The samples from the great mines at Lowmoor and Longdale gave, respectively, 43 b and 44 per cent. iron, and 48 and 52 per cent. iron.

The shales of the Hamilton period contain workable ores in Pennsylvania. In the Marcellus shales at some points, as in Perry county, the ore reaches, locally, a thickness of 12 to 14 feet. It is a loose limonite, imbedded in clay above the drainage-level, but below that level it changes to a hard, blue carbonate of iron. Mr. McCreath's analyses give 35 to 43 per cent. iron, with a phosphorus ratio ranging from 0.179 to 0.281.

In Pennsylvania the Hamilton sandstone (Montebello) also carries ore often with a thickness of about 2 feet, and more or less fossiliferous. In Virginia the Devonian shales are highly charged with pyrites, which within the zone of oxidation gives rise to great amounts of copperas and alum shale, and sulphurous and chalybeate waters, but the local occurrences of iron-ore are of inferior quality.

The same may be said of the formation in Tennessee, where it is more bituminous and thinner. c

A peculiar fossil-ore, very fossiliferous, and known as Mansfield ore, occurs in the Chemung, in Pennsylvania, and has been mined at several points with a thickness of 1½ to 3 feet.

Formation IX—the Catskill—contains some impure ore in small quantities in Virginia.

In Pennsylvania the Mauch Chunk red shales (XI) just beneath the millstone-grit, are topped by a plate of carbonate of iron, known as the "Red-ore bed". This occurs throughout northern and western Pennsylvania, but has been successfully worked only in Fayette county. In Virginia, where this formation consists of red, green, and yellowish shales, with argillaceous limestones, nodular carbonates of iron also occur. In the interior of the continent the sub-Carboniferous consists mainly of limestones. In western Kentucky and Tennessee there occur large amounts of residuary limonite, resting on the lowest sub-Carboniferous limestone—the Protean of Safford. It occurs as pots, strings, pipe-ore, and honeycomb-ore, scattered through deposits of clay and chert often 100 feet d thick. This is doubtless the insoluble residuary ruin of a great thickness of formerly *superincumbent* limestone strata.

In Kentucky the sub-Carboniferous limestone on the Kentucky and Red rivers carries on its top a carbonate ore, known as the "lower limestone ore", which is sometimes as much as 3 feet thick. It occurs in jointed blocks, which are changed to limonite excepting a core of carbonate. In Ohio the sub-Carboniferous limestone carries a good block-ore on its upper surface, which, together with occasional kidneys of ore in the overlying clays, has been mined in connection with the associated limestone, which was used for furnace-flux, but it does not appear to be sufficiently permanent and thick to be mined alone.

In central and western-central Missouri the sub-Carboniferous consists of limestones and sandstones. One of the sandstones, or probably different sandstones, carries a bed of red hematite ore, varying from 1 to 5 feet thick. This varies from highly ferruginous sandstone to pure ore. Coherent deposits of limonite occur in the Upper Osage e river in the Encrinital limestone, and are among the most important sources of limonite in the state. They have the character of ores formed in cavities in the limestone. An ore-sheet, a few inches thick, mixed with pebbles, and known as Guinea-fowl ore, occurs at points in the Conglomerate XII, and has been mined to a very limited extent, but is practically worthless.

The ores of the Carboniferous period may be divided into two classes, viz: Ores occurring in the shales; ores occurring in connection with the limestones.

Doubtless the iron-stones of this age occur coextensively with the Coal Measures; but they are known and more or less worked only in parts of the great Carboniferous area. In different counties of Pennsylvania and Ohio these ores occur at various horizons in workable beds.

The most important known occurrences of iron-stones in the Coal Measures in Pennsylvania appear to be the f following:

I. The ferriferous limestone in the western part of the state, and belonging a few feet below the lower Kittanning coal in the Lower Coal Measures. This limestone, which varies from 4 to 25 feet in thickness, has frequently its upper portion, varying from 6 inches to several feet, altered to limonite, which is known as "buhrstone" ore. In some places the ferriferous limestone is replaced for its entire thickness, 20 feet or more, by ore. Frequently the shales just above the limestone also yield "ball-ore".

II. At Johnstown, the "Johnstown ore-bed", 2 feet thick, 71 feet above the upper Freeport coal.

III. In Fayette county there are five beds of lump and flag clay iron-stone within 25 feet below the Pittsburgh coal. Two more occur overlying the Mahoning sandstone, besides the Pridevale beds underlying it. There are also the Stratford beds overlying the conglomerate.

a The carbonaceous carbonate ore—"blackband"—which has played such an important part in the history of iron-making in Great Britain, has been found in several localities in this country—in Alabama, West Virginia, Ohio, and Kentucky. In North Carolina blackband occurs with the Triassic coal. In Alabama a 12-inch seam was worked in the census year. It contained 29 per cent. of iron with a phosphorus ratio of 0.658, and was associated with a black shale carrying 8 per cent. of iron with a phosphorus ratio of 1.372.

In Louisa county, Kentucky, there is known a seam of blackband 16 inches thick overlaid by 15 inches of black bituminous shale. It is known at several points in West Virginia. Mr. S. P. Sharples gives the analysis of a raw blackband from a persistent seam 9 miles from Charleston, in West Virginia, viz, 31.46 per cent. iron, 0.41 sulphur, and 0.25 phosphorus.

b Mr. Proctor, of the Kentucky survey, states that the Coal Measures of the Western Coalfield contain persistent beds of ore of workable thickness, sometimes 6 feet thick, and carrying from 35 per cent. to 42 per cent. of iron in the unroasted ore.

With one or two very slight exceptions, all the ore now mined in Ohio comes from the Lower Coal Measures. There are three important horizons of carbonate ores, the working thickness of which over large areas is often 6 feet with local swelling to 18 or 19 feet. These horizons are, according to Professor Orton—

1. Upper Freeport coal; the main blackband horizon; here belong also clayband ores.
2. Forty feet below Lower Mercer, interconglomerate limestone; confined to southern Ohio, ["Flag ore," "Boggs ore."]
3. Sharon coal; interconglomerate blackband.

c Kidney ores are mined at various points in Ohio. They are scattered through the shales and fire-clays of 5 or 6 tolerably well marked horizons, in some of which they are quite persistent, viz:

1. Upper Freeport limestone, in southern Ohio.
2. Lower Freeport limestone, in southern Ohio.
3. Kittanning shales, between Kittanning coals.
4. Ferriferous limestone and Clarion coals.
5. Putnam Hill limestone, in southern Ohio.

The ferriferous limestone, celebrated for its "buhrstone" ore, in Pennsylvania, is equally important in southern Ohio, where, in the Hanging-Rock district, it carries in its upper portion 6 to 12 inches of more or less altered carbonate, known in Ohio and Kentucky as "limestone ore".

d Reviewing these horizons as observed by Professor Orton, from whom I have taken the notes on the Ohio ores, we find them to number twelve, distributed through the Lower Coal Measures, and ranging from the Sharon coal to the upper Freeport, viz:

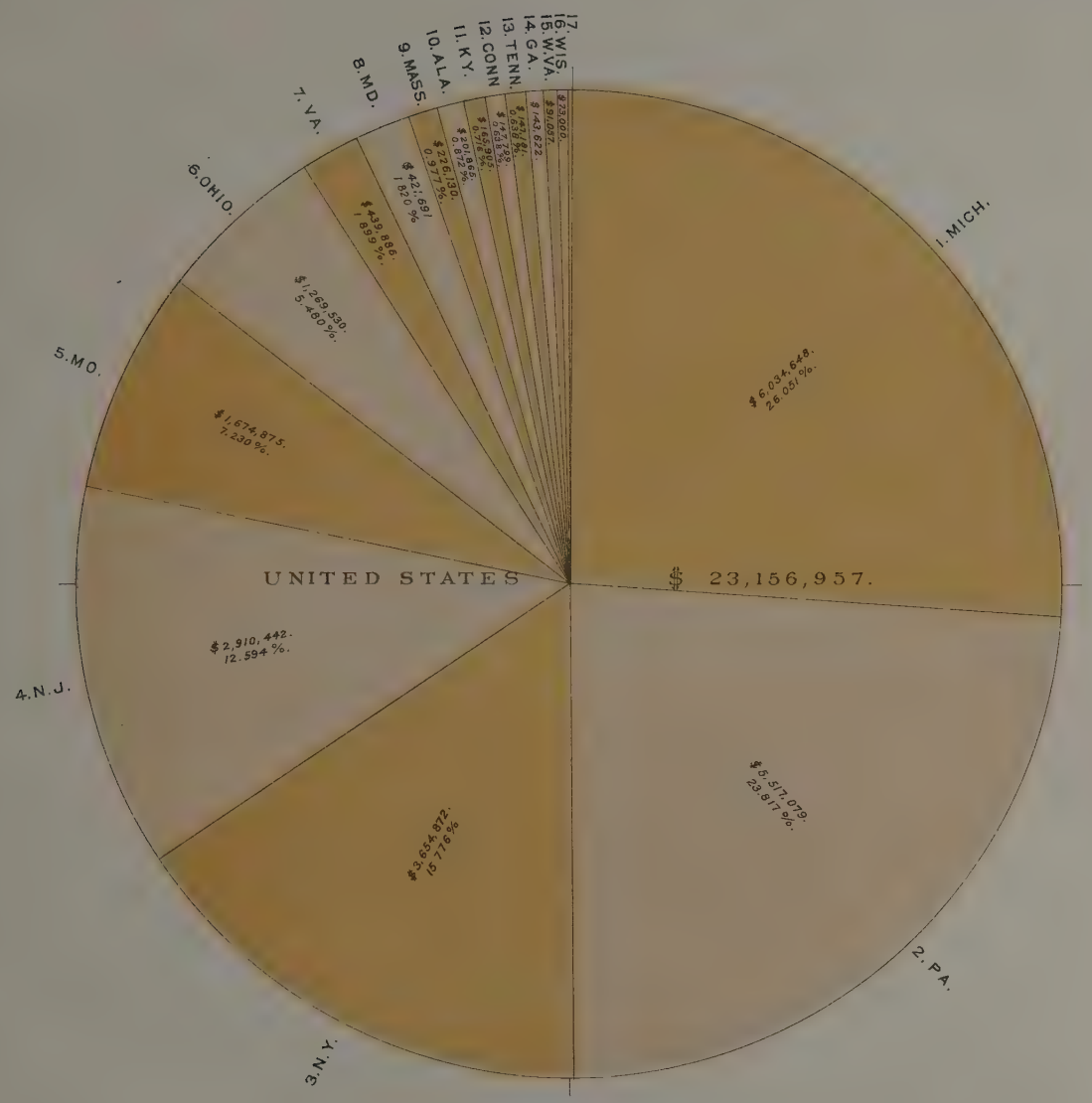
Upper Freeport coal.
Upper Freeport clay.
Upper Freeport limestone.
Lower Freeport limestone.
Kittanning shales.
Ferriferous limestone.
Putnam Hill limestone.
e Upper Mercer limestone.
Mercer shales.
Lower Mercer limestone { Above. / Below.
Interval between Mercer and Sharon groups, Sharon coal.

A hematite occurs in layers of concretions in the inclined beds of the Trias in Moore county, North Carolina; and in Chatham county of the same state, a seam of blackband, 18 inches thick, forms the roof of a seam of Triassic coal, and, with black shale, the floor of another. It carries 21 per cent. of iron, with the remarkably low phosphorus ratio of 0.080. The shales above the coal-seams also contain carbonate ball-ore.

In the deposition of the great lignitic groups of the Cretaceous west of the Missouri river conditions existed f similar to a great extent to those which surrounded the formation of the older Coal Measures; and we also find clay-ironstone nodules in the fire-clays that accompany the lignite.

In some places, according to Mr. Putnam, where the fine shales have been removed by waste, and especially by wind, these nodules remain as a residuary, sometimes workable, deposit on the surface of the plains.

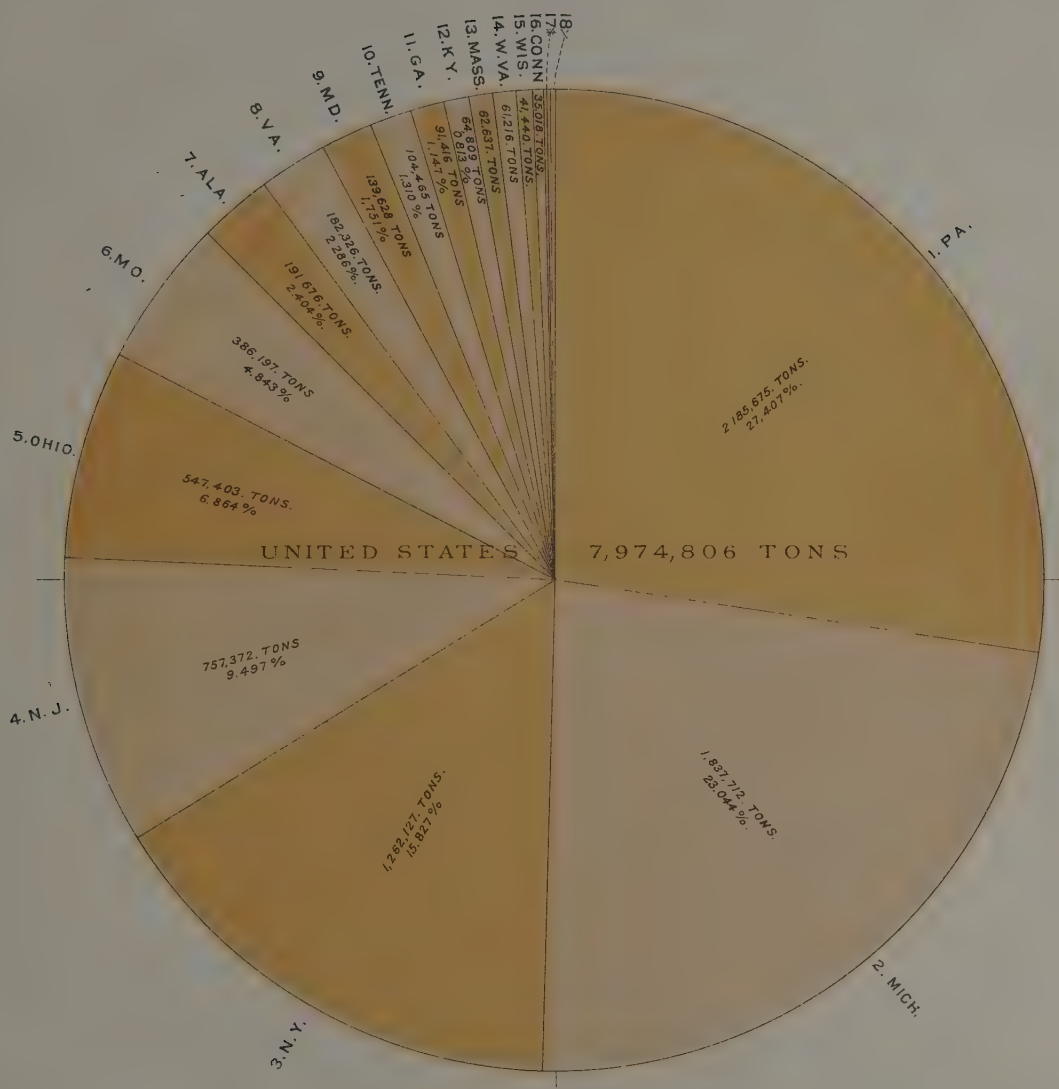
In eastern Maryland, from north of Baltimore to near Washington, District of Columbia, there is a long line of small mines, which have produced clay-ironstone nodules more or less altered to hematite and limonite. These nodules occur in a stiff clay, probably of Mesozoic age. These ores range from 36 to 48½ per cent. iron, and in phosphorus ratio 0.065 to 0.399. The basaltic rocks of the Cascade range exposed to the immense rainfall and luxuriant vegetation of the northern Pacific coast have contributed to the formation of very extensive deposits of bog-ore. That such deposits were forming probably during the Tertiary period is shown by the Prosser mine near Portland, in Oregon. Here a bed of limonite 6 to 8 feet thick, still showing in places more or less the texture of bog-ore, and containing roots and trunks of a former forest-growth, lies upon a bed of basalt and is covered by



17.–a. ME.($ 9,000); b. TEX.($ 8,100); c. DEL.($ 6,553); d. N.CAR.($ 5,285); e. OR.($ 4,669); f. VT.($ 2,750); g. IND.($ 1,018); = $ 37,375.

VALUE OF THE IRON ORE MINED IN THE CENSUS YEAR, BY STATES.

Julius Bien & Co Lith.



*17.a. OR. (6,972); b. ME. (6,000); = 12,972. TONS.
†18.a. TEX. (3,600); b. N. CAR. (3,318); c. DEL. (2,726); d. VT. (560); e. IND. (513) = 10,717. TONS.

IRON ORE MINED IN THE CENSUS YEAR, BY STATES.

Julius Bien & Co Lith.

many hundred feet of more recent basalt, the whole dipping about 10° to 20° to the westward. Two samples gave a 44.71 and 54.19 iron, and phosphorus ratios respectively of 1.490 and 0.723. Part of the bed is altered to a compact mineral-like brown pitch stone, containing 30 per cent. of iron. Similar ores are forming to day in the great marshes from the chalybeate waters drained from the decomposing basalt of the Cascade range.

Limonite in several varieties, especially bog-ores, occurs in deposits of recent age at many points in the Atlantic states. While this class of ores contributed nothing to the iron industry in the census year of 1880, they were of relatively great importance in the early period of American iron-making. As there can be little doubt that they will become useful ores under the processes of the future, they must count as prospective elements of the national wealth.

It was my original intention to combine with the special canvass of the statistics of the mining industries east of the 100th meridian a more special study of the iron-ore resources of the country at large. The whole b organization of the work was framed to include this investigation by separate observers, and nearly all the field-work was actually finished, when the inadequacy of the census appropriation necessitated an extensive contraction of the plan. Commercial and differential samples had been fully collected of the ores of all mines excepting the carbonate ores of West Virginia.

The original intention of extending complete analyses to the ores of all large mines, and to all others in which for various reasons such analyses might be supposed to have a metallurgical value, was also abandoned, and the complete analyses were stopped at the point at which they had already arrived, with some important exceptions. The scope of the partial analyses was also thenceforth limited largely to the determination of iron and phosphorus. The plan of studying the structural features of the ore-deposits and their genetic phenomena was the one that I gave up with the greatest reluctance; for in a statistical survey of the resources of the United States in iron-ore an c approximative result can be obtained only after obtaining light on a few fundamental points, and especially the following:

1. In the Archæan ores are the "pods" of the Highlands and the "lenses" of Michigan simply isolated masses, of rare occurrence, and in widely-separated horizons, or do they occur grouped near together, in places in overlapping lenses, in others scattered along the same straight or folded plane of bedding, and separated only by greater or less stretches of "barrens" or "pinches"?

2. Regarding our next great reliance for the future—the limonite bodies of the great Appalachian valley—are they limited as ore-producers to the present region of drainage, or has the oxyhydration or mineralization, as the case may be, extended to a greater depth, dependent either upon some former drainage conditions or upon some process acting independently of drainage? d

And do these limonite bodies in depth change to corresponding rich parent bodies of carbonate of iron, or to earthy carbonates containing iron, which remains as an insoluble residue after the leaching away of the former; or, again, are they in some instances produced mainly by the reaction of iron-salts upon limestone, and in others by the rapid decomposition of alkaline hydromica-schists to clays, in which the iron from the decomposed silicates segregates to form fragmentary limonite? Similar fundamental questions remain to be solved with reference to the great specular deposits of Missouri, and, to a certain extent, also, with regard to the "fossil" and related ores. This investigation will doubtless be carried out by the National Geological Survey, within whose domain it falls. But, although much curtailed, there still remain enough results from the sampler's notes, the laboratory work, and the statistical canvass proper to classify very clearly the iron-ore fields and the ore-product of the census year according to its richness in iron and its content of phosphorus, and to present the industry in its broader economic e aspects. This I have attempted to do by means of the following tabular and graphic statements, which, with the exception of plates VII and VIII, were calculated and drawn up by my assistant, Mr. Bayard T. Putnam:

They are:

Plate VII.—Map of the United States, showing the geographical distribution of the iron-ore fields. (Faces p. 3.)

Plate VIII.—Chart showing the geological distribution of the iron ores in each state. (Faces p. 4.)

Plate IX.—Diagram showing the relative values of the ore mined in each state in the census year.

Plate X.—Diagram showing the relative amounts of ore mined in each state in the census year.

Plate XI.—Diagram showing the relative amounts of the several kinds of ore mined in the United States in the census year. This is a graphic presentation of the totals of table 7.

Plate XII.—Diagram showing the relative amounts of each kind of ore mined from each geological horizon in f the census year. This is a graphic presentation of the totals of table 6.

Table 6.—Table showing the amount of each kind of ore mined from each geological horizon in each state in the census year. The totals of this table are graphically presented in plate XII.

Plate XIII.—Diagram showing the relative amounts of each kind of ore mined in each state in the census year. This is a graphic presentation of table 7.

Table 7.—Table showing the amounts of each kind of ore mined in each state in the census year. The details of this table are shown graphically on plate XIII, and its totals are shown graphically on plate XI.

Plate XIV.—Map of the United States, showing by different intensities of one tint the relative amounts of ore mined in the census year. A star on this map indicates the "center of total production of iron ore in the census year". (See p. 37.)

a *Plates XV to XXI.*—Maps of different portions of the United States, showing by different intensities of one tint and by figures in different colors the relative total amounts of ore and the relative amounts of each kind of ore mined in each ore-producing county in the census year. These maps exhibit graphically the data contained in table 8.

Table 8.—Table showing the amounts of each kind of ore mined in each ore-producing county in the census year. Plates XV to XXI exhibit these data graphically.

Plate XXII.—Diagram showing (*a*) a classification of the ore mined in the United States in the census year according to kind of ore and its per cent. of metallic iron, and (*b*) a classification of the total metallic iron in the ore according to kinds and grades of ore which contained it. These diagrams are graphic representations of the b data contained in table 9.

Table 9.—Table showing (*a*) a classification of the ore mined in the United States in the census year according to kind of ore and its per cent. of metallic iron, and (*b*) a classification of the total metallic iron in the ore according to kinds and grades of ore which contained it. The data in this table are graphically presented in plate XXII.

Table 10.—Table showing a classification of the ore mined in each state in the census year according to kind of ore and its per cent. of metallic iron. The totals of this table are recapitulated in table 9, and are presented graphically on plate XXII.

Table 10 *a*.—Table showing a classification of the metallic iron contained in the ore mined in each state in the census year according to kinds and grades of ore which contained it. This table is calculated from table 10. Its totals are repeated in table 9 and appear graphically on plate XXII.

c *Table* 11.—Table showing a partial classification of the ore mined in each state in the census year according to kind of ore and its phosphorus-iron ratio.

Table 12.—Table showing the amount of each kind of ore mined in each state in the census year having a sufficiently low phosphorus-iron ratio to be classed as Bessemer ore. These facts are presented graphically on plates XXIII and XXIV.

Plate XXIII.—Diagrams showing (*a*) the relative amount of Bessemer ore to the total ore product in the census year, (*b*) the relative amounts of the different kinds of ore in the Bessemer ore product, and (*c*) the relative amounts of Bessemer ore mined in each state. These are graphic presentations of the facts contained in table 12.

Plate XXIV.—Diagram showing the relative amounts of the different kinds of Bessemer ore mined in each state in the census year. These facts are presented also in table 12.

d *Table* 13.—Table showing the royalties paid on the different kinds of ore in each state in the census year.

PLATE VII.

Plate VII is intended to represent the ore-fields of the country to the extent to which they have been shown to be workable in the past. For this purpose the range of the ores is represented by colors selected for the different kinds. Only the limits are represented within which the ores have been proved to exist in more or less sporadic deposits. The progress of the iron industry will extend the limits of these colors to a greater or less extent, but within areas (east of the 100th meridian) which can now be tolerably well defined, as I have stated on page 4. Notably by far the greatest extension will fall to the coloring of the ores of the Carboniferous. But the extension e which can safely be predicted for the coloring of the Siluro-Cambrian ores in Missouri, and the Archæan ores on the south and north sides, of Lake Superior, will be of vast national importance.

Also, the map shows, by the dots in the ore-fields, the proximate position of the mines, or groups of mines, which were working or were sampled during the census year.

One of the most salient facts on plate VII is the lack of any relation between the area of an ore-field and its production; there is also no relation between its area and its capacity for production. Thus in Michigan, whose ore-product represented 23.04 per cent. of the total quantity, and 26.05 per cent. of the total value of the ore-product of the whole United States, the area of the ore-fields is so small as to almost escape observation on the map. On the other hand, Pennsylvania, with a little larger percentage of quantity—27.4 per cent.—and a little smaller percentage of value—23.8 per cent.—is represented by areas aggregating perhaps nearly 300 times that of the f Michigan ore-fields, as represented on the map. Again, of the ore mined in Pennsylvania, more than one half the quantity came from small colored areas in the southeastern counties, aggregating less than one-fiftieth of the total area colored as the ore-fields of the state.

In seeking the explanation of this fact we find two causes:

First. Although only the Coal Measure areas within which the carbonate ores occur have been worked are colored, their tint covers an immense region. But owing to their low percentage in iron and the necessity of driving off the carbonic acid, these ores contributed only about 11½ per cent. of the total ore tonnage and probably less than 7 per cent. of the value.

Second. The ores of the Carboniferous and Upper Silurian formations lie horizontally, or nearly so, in beds from a few inches to a few feet—rarely 5 feet—thick. Thus the capacity of each mine is only a few thousand tons—five- to twenty-thousand—per acre. On the other hand, the great ore resources of the Siluro-Cambrian, and, in a

much greater degree, of the Archæan formations, are concentrated into deposits of enormous contents underlying a small areas.

PLATE VIII.

I have had plate VIII compiled to accompany my remarks on the distribution of the iron ores in the various geological formations of

The compilation has been made by Mr. Willis from the reports of the various state geological surveys, as well as the difficulties of the case will permit, and will, I think, on the whole, be found correct.

Instances of disputed horizons will be observed, notably the magnetic ores of Pennsylvania that underlie the Triassic sandstone, and are traversed by the traps, and which are in the chart assigned to the Lower Silurian. b The reasons for this are given in the text.

The position assigned to the spathic ore of Roxbury, Connecticut, is also very doubtful.

The known ore deposits of the five great varieties are represented, and where any of the varieties were mined in the state during the census year the tonnage is given.

PLATES IX AND X.

An examination of plates IX and X shows that of the nearly 8,000,000 tons of ore, with a spot value of a little over $23,000,000, nearly one-half the amount, and over one-half the value, was produced by the two states of Michigan and Pennsylvania, and that while Pennsylvania produced the larger part of the tonnage, Michigan is credited with the larger part of the spot value. New York comes third, and New Jersey fourth, both as to tonnage c and value; and these four states—Michigan, Pennsylvania, New York, and New Jersey—together produced more than three-fourths, or, more exactly, 78.2 per cent. of the tonnage, and 75.8 per cent. of the spot value.

Mr. Putnam has tabulated the data contained on these plates, adding the average spot value of the ore of each state, the percentage contributed by the mines of each state to the total metallic-iron product of the United States, and the relative position of each state, first, in the order of tonnage; second, in the order of total value; third, in the order of percentage in metallic iron; fourth, in the order of the average spot value per ton. Four columns have also been added showing for the Bessemer ore product of each state the tonnage, its ratio to the national product of Bessemer ore and to the state's total product, and the order of the state according to the amount of Bessemer ore mined: d

States.	Amount of ore mined.		Value of ore mined.		Amount of metallic iron in ore mined.		Average per cent. of metallic iron in ore.	Bessemer ore mined.			Average spot value of ore per ton.	Order of states according to amount of ore mined.	Order of states according to total value of ore mined.	Order of states according to amount of metallic iron in ore mined.	Order of states according to average per cent. of metallic iron in ore.	Order of states according to amount of Bessemer ore mined.	Order of states according to average spot value of ore per ton.
	Tons.	Per cent. of total.	Dollars.	Per cent. of total.	Tons.	Per cent. of total.		Tons.	Per cent. of Bessemer product.	Per cent of state's product.							
Alabama	191,676	2.404	$201,865	0.872	97,139	2.378	50.67				$1 05	7	10	7	8		22
Connecticut	35,018	0.439	147,799	0.638	15,769	0.388	45.03				4 22	16	12	16	12		3
Delaware	2,726	0.034	6,553	0.028	1,082	0.026	39.67				2 40	21	19	21	21		12
Georgia	91,416	1.147	143,622	0.621	46,964	1.149	51.37				1 57	11	14	11	7		18
Indiana	513	0.007	1,018	0.004	231	0.005	45.00				1 98	23	23	23	13 to 18		15
Kentucky	64,809	0.813	165,905	0.716	26,343	0.645	40.64				2 56	12	11	13	20		9
Maine	6,000	0.075	9,000	0.039	2,700	0.066	45.00	6,000	0.28	100.00	1 50	18	17	18	13 to 18	7	19
Maryland	139,628	1.751	421,691	1.820	59,190	1.449	42.39				3 02	9	8	9	19		7
Massachusetts	62,637	0.785	226,130	0.977	28,187	0.690	45.00				3 61	13	9	12	13 to 18		5
Michigan	1,837,712	23.044	6,034,648	26.051	1,094,814	26.798	59.57	948,589	43.47	51.61	3 28	2	1	1	2	1	6
Missouri	386,197	4.843	1,674,875	7.230	231,766	5.673	60.01	287,980	13.20	74.56	4 33	6	5	5	1	4	2
New Jersey	757,372	9.497	2,910,442	12.594	406,953	9.961	53.73	114,841	5.26	15.16	3 84	4	4	4	5	5	4
New York	1,262,127	15.827	3,654,872	15.776	681,534	16.680	53.99	360,821	16.55	28.58	2 89	3	3	3	4	3	8
North Carolina	3,318	0.041	5,285	0.023	1,816	0.044	55.03	2,862	0.13	86.25	1 59	20	20	19	3	9	17
Ohio	547,403	6.864	1,269,530	5.480	211,452	5.177	38.62				2 31	5	6	6	22		13
Oregon	6,972	0.087	4,669	0.020	3,137	0.077	45.00				67	17	21	17	13 to 18		23
Pennsylvania	2,185,675	27.407	5,517,079	23.817	989,806	24.228	45.28	448,374	20.56	20.51	2 52	1	2	2	11	2	10
Tennessee	104,465	1.310	147,181	0.638	52,863	1.294	50.59	5,600	0.26	5.36	1 41	10	13	10	9	8	21
Texas	3,600	0.046	8,100	0.035	1,620	0.040	45.00				2 25	19	18	20	13 to 18		14
Vermont	560	0.007	2,750	0.012	252	0.006	45.00				4 91	22	22	22	13 to 18		1
Virginia	182,326	2.286	439,886	1.899	86,799	2.125	47.60	6,160	0.28	3.37	2 41	8	7	8	10	6	11
West Virginia	61,216	0.767	91,057	0.394	23,214	0.568	37.92				1 48	14	15	14	23		20
Wisconsin	41,440	0.519	73,000	0.316	21,784	0.533	52.56				1 76	15	16	15	6		16
The United States	7,974,806	100.000	23,156,957	100.000	4,085,418	100.000	51.22	2,181,227	100.00		2.90						

a Among the several factors that enter into the causation of the differences in the average value of the ore at the mines, the most important is the proportion of Bessemer ore (see plate XXIII) in the product of each state, and the relative average richness of the state's total product in metallic iron.

Ohio produced only the relatively low-grade ores of the Carboniferous, and no Bessemer ores, and while her tonnage was 6.864 per cent. of the total tonnage, its value was only 5.480 per cent. of the total value.

On the other hand the product of Missouri was of high grade hematite, nearly three-quarters of which was Bessemer ore; and while her tonnage was 4.834 per cent. of the total tonnage, its value was 7.230 per cent. of the total value.

The importance of this cause is shown, perhaps best, in comparing Ohio with Michigan. As we have seen, **b** Ohio's tonnage percentage was 6.846, and value percentage, 5.480; on the other hand, the high-grade product of Michigan, one-half of it Bessemer, has a tonnage percentage of 23,044 and value percentage of 26.051, notwithstanding the fact that its product has to be carried over 600 miles by rail, water, and again by rail, to the furnaces of Ohio, Illinois, and Pennsylvania.

It appears from the above table that the first, third, and fifth rank, as regards average spot value of the ore, belongs respectively to Vermont, Connecticut, and Massachusetts. The aggregate product of these three states was less than 100,000 tons, or about one-eightieth of that of the country at large. The high valuation is due partly to the fact that these ores have a special value for car-wheels.

Missouri occupies (after Vermont) the first rank for average spot value, partly because she worked in that year only her richer hematite and magnetite mines, thus taking highest rank for average per cent. of iron in ore, and **c** partly because three-quarters of the product from these mines was adapted to Bessemer; but the high average spot value was doubtless due mainly to the fact that the owners of Iron Mountain, the largest producers, maintained a high price for their ore.

New Jersey ranked fourth in average spot value of ore, although among the producers of Bessemer ore she ranked seventh as regards proportion of Bessemer to non-Bessemer ore, and fifth as regards total product of Bessemer, and fifth in point of average percentage of metallic iron.

It is noticeable that while New Jersey ranked fourth as to amount of ore mined, it ranked fourth also as to total value, as to amount of metallic iron in the ore-product of the state, and as to average spot value of the ore; and she ranked fifth as to average per cent. of metallic iron in her ore, and also as to the amount of Bessemer ore mined.

d New Jersey ranked below her neighbor, New York, in every one of these points, except the average value of the ore, and here she ranked fourth while New York stood eighth. The difference (New York ores averaged $2 89 as against $3 84 for New Jersey) was due to the proximity of the New Jersey ores to the anthracite fields.

The effect of geographical position on the average spot value of the ore is shown more clearly in Michigan. This state ranked first as to total spot value of ore, first as to amount of metallic iron contributed by its ore product, first as to amount of Bessemer ore mined. She ranked second as to average percentage of iron in the ore, which contained 59.57 per cent. iron as against 60.01 per cent. in the Missouri ore, which ranked first. With all these great advantages, she ranked sixth in point of average spot value of the ore.

On the other hand, the value of these advantages of quality is shown in the comparison of Michigan with Pennsylvania. The latter state, which ranked first in tonnage and second in total value and in amount of metallic **e** iron contributed by its ore, and second also as to quantity of Bessemer ore mined, but being sixth as regards the ratio of Bessemer ore to non-Bessemer, and eleventh as to average percentage of iron in the ore (45.28 per cent.), it is not surprising to find her ranking tenth as to the average spot value of her ore—$2 52 as against $3 28 for Michigan.

High percentage in iron and qualities that meet the requirements of special demands, especially a low phosphorus ratio, are the conditions that raise the spot value, while cost of transportation tends to lower it.

PLATE XI.

Plate XI exhibits graphically the relative importance of the different varieties of the ores, and should be examined in connection with plates XII and XXII.

f The magnetites, mainly Laurentian (plate XII), form 29.975 per cent. of the tonnage, and contain 32.178 per cent. of the total metallic iron (plate XXII).

Next, the limonites, mainly Lower Silurian, form 26.950 per cent. of the tonnage, and contain 24.319 per cent. of the total metallic iron.

The third great factor, the hematites, mainly Huronian, with 23.791 per cent. of the tonnage, contain 27.717 per cent. of the total metallic iron.

The low-grade carbonate and derivatives, almost wholly from the Coal Measures and sub-Carboniferous, form 11.565 per cent. of the tonnage and contain 8.593 per cent. of the total metallic iron.

And the "fossil" ore, wholly Upper Silurian, form 7.717 per cent. of the tonnage, and contain 7.193 per cent. of the total metallic iron.

It shows that there were mined of the five great varieties of iron ore as follows, as represented in the totals of **a** table 7:

Ores.	Tons.	Per cent. of total.
Magnetite	2,390,389	29.975
Limonite	2,149,417	26.952
Hematite	1,897,218	23.791
Carbonate	922,288	11.565
Fossil	615,494	7.717
Total	7,974,806	100.000

b

TABLE 6.—*Iron ore mined in the census year, by geological horizons, by states and by kinds.*

[Compare with plate XII for the graphic presentation of the totals.]

States.	LAURENTIAN.				HURONIAN.				LOWER SILURIAN.			
	Limonite.	Hematite.	Magnetite.	Total.	Limonite.	Hematite.	Magnetite.	Total.	Limonite.	Hematite.	Magnetite.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama									110,696			110,696
Connecticut									35,018			35,018
Delaware												
Georgia									44,210			44,210
Kentucky												
Indiana												
Maine												
Maryland									64,760		218	64,978
Massachusetts									62,637			62,637
Michigan					329,897	1,359,096	148,719	1,837,712				
Missouri						201,450		201,450	112	184,635		184,747
New Jersey			741,864	741,864					15,508			15,508
New York			927,052	927,052					145,550	94,765		240,315
North Carolina			2,650	2,650	516		152	668				
Ohio												
Oregon												
Pennsylvania			152,869	152,869					1,084,752	15,832	405,055	1,505,639
Tennessee									15,447			15,447
Texas												
Vermont										560		*a* 560
Virginia					1,351	13,440	11,810	26,601	42,392	28,000		70,392
West Virginia												
Wisconsin									2,240			2,240
The United States			1,824,435	1,824,435	331,764	1,573,986	160,681	2,066,431	1,624,322	323,792	405,273	2,352,387

States.	UPPER SILURIAN.			DEVONIAN.			SUB-CARBONIFEROUS. Limonite.	CARBONIFEROUS. Carbonates and derivatives.	MESOZOIC. Carbonates and derivatives.	CENOZOIC. Limonite.	Total.
	Fossil.	Limonite.	Total.	Fossil.	Limonite.	Total.					
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama	75,218		75,218					5,762			191,676
Connecticut											35,018
Delaware										2,726	2,726
Georgia	47,206		47,206								91,416
Kentucky							17,660	47,149			64,809
Indiana							513				513
Maine										6,000	6,000
Maryland	1,018		1,018						73,632		139,628
Massachusetts											62,637
Michigan											1,837,712
Missouri											386,197
New Jersey											757,372
New York	85,442		85,442							9,318	1,262,127
North Carolina											3,318
Ohio								547,403			547,403
Oregon										6,972	6,972
Pennsylvania	283,637	6,720	290,357	212	39,224	39,436		197,374			2,185,675
Tennessee	76,561		76,561				12,457				104,465
Texas										3,600	3,600
Vermont											560
Virginia		85,333	85,333								182,326
West Virginia	7,000	3,248	10,248					50,968			61,216
Wisconsin	39,200		39,200								41,440
The United States	615,282	95,301	710,583	212	39,436	39,436	30,630	848,656	73,632	28,616	7,974,806

a The age of this ore is very doubtful.

TABLE 6 AND PLATE XII.

a Table 6, showing the amounts of iron ore mined by geological horizons, kinds, and states, should be consulted in connection with plate VIII, the geological chart showing the distribution of the various ores in the geological column of the different states, and also with the statistical graphic plate (XII) showing the amounts of ore mined by geological horizons and kinds. The last-mentioned diagram is, as will be readily seen, constructed from the totals of table 6.

It is not necessary to emphasize the fact that neither the table nor the two plates represent the relative capacity of the different horizons or the different states; the special requirements of the iron industry of the period in question and the newness of the ore industry in some of the states, caused the demand to bear very unequally on the production of different varieties of ores and of different geographical areas.

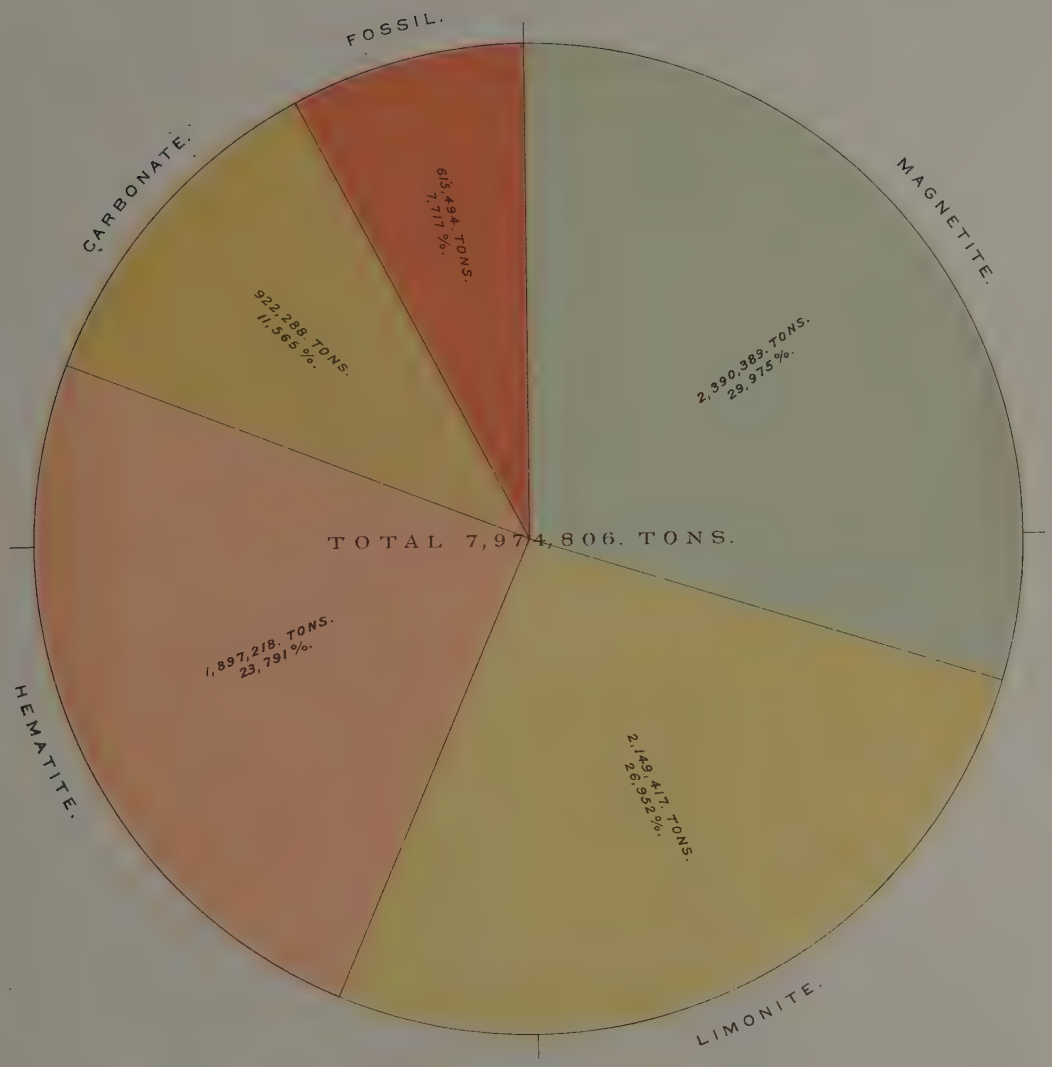
b From these representations, especially from plate XII, it will be seen that nearly one-half of the ore product of the country was mined from the Archæan, the Huronian producing a little more than the Laurentian. The Lower Silurian, essentially the deposits in the Siluro-Cambrian limestone, produced more ore than either one of the members of the Archæan.

Plate XII shows, also, in a very striking manner, that each of the great ore-bearing horizons is remarkable for an immensely preponderating ore which is different from the dominant ores of the other great horizons. Thus the magnetites are peculiarly Laurentian, the specular hematites Huronian, the limonites Siluro-Cambrian, the fossil hematites Upper Silurian (Clinton), and the carbonates almost peculiar to the Carboniferous.

c It is proper to say here that a certain amount of what is shown as Huronian hematite—several hundred thousand tons—is martite, and therefore, while for all commercial purposes it is a hematite, in its geological and genetic relations it is a magnetic ore. Further, the ores classed as Huronian limonites are all derived from hematite, while on the other hand the Lower Silurian magnetites of Pennsylvania are altered limonite bodies.

From this table it appears that the different geological horizons produced of the different varieties as follows:

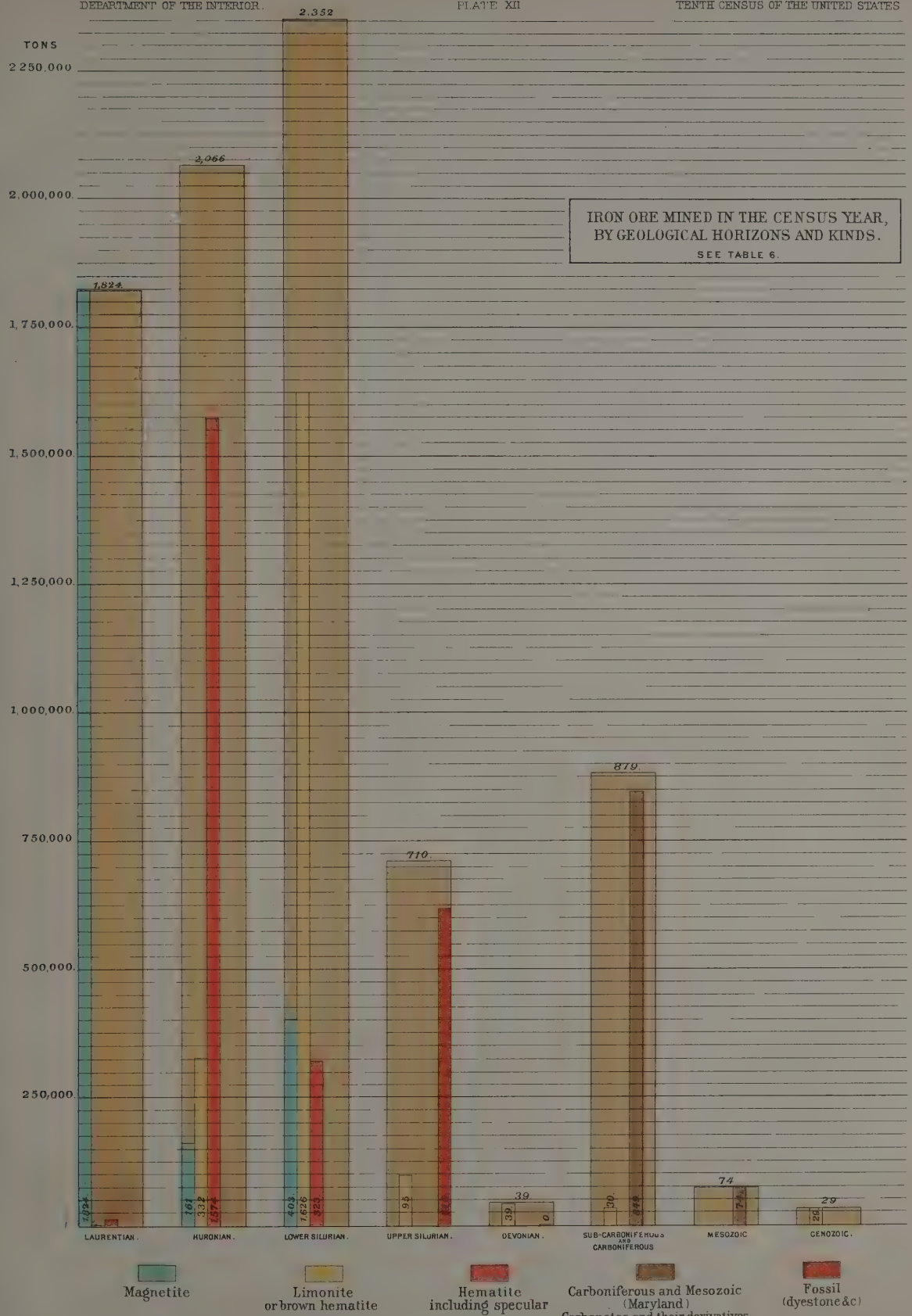
LAURENTIAN:	
Magnetite	1,824,435
Total	1,824,435
HURONIAN:	
Limonite	331,764
Hematite	1,573,986
Magnetite	160,681
Total	2,066,431
LOWER SILURIAN:	
Limonite	1,624,322
Hematite	323,792
Magnetite	405,273
Total	2,352,387
UPPER SILURIAN:	
Fossil hematite	615,282
Limonite	95,301
Total	710,583
DEVONIAN:	
Fossil hematite	212
Limonite	39,224
Total	39,436
SUB-CARBONIFEROUS:	
Limonite	30,630
Total	30,630
CARBONIFEROUS:	
Carbonates and derivatives	848,856
Total	848,856
MESOZOIC:	
Carbonate and derivatives	73,632
Total	73,632
CENOZOIC:	
Limonite	28,616
Total	28,616



Note: *All the coal measure ores (Carbonates and their derivative limonites) are placed under "carbonates". The Carbonate ores of Maryland are also put in that section.—The specular ores are classed with the hematites.*

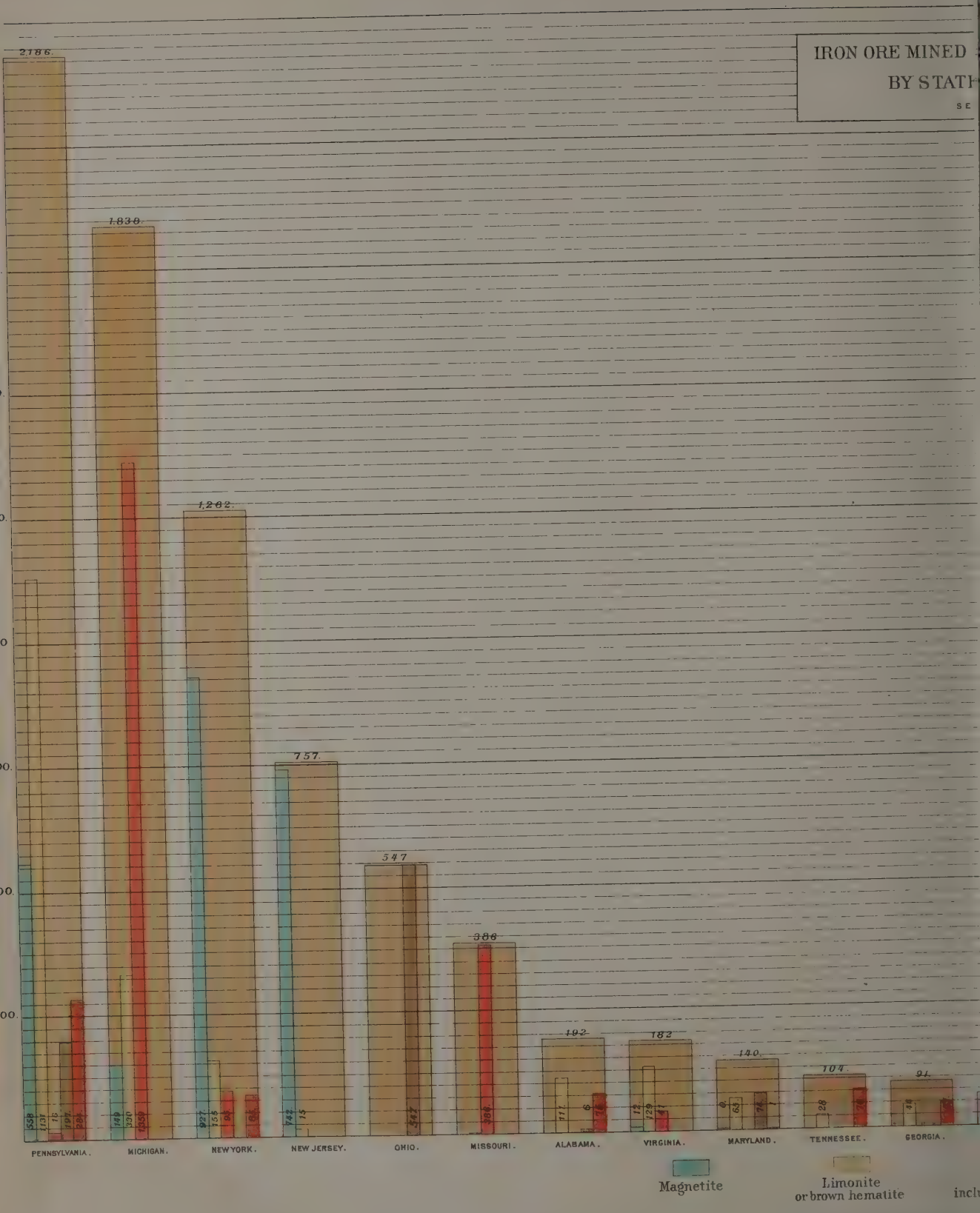
Julius Bien & Co Lith.

IRON ORE MINED IN THE CENSUS YEAR, BY KINDS.



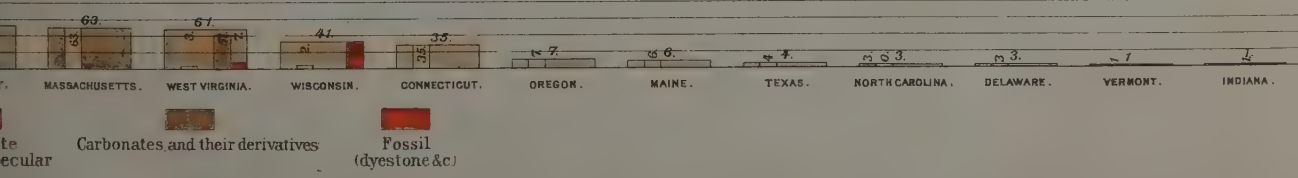
The total product of ore of each horizon is shown by the extreme height of the grey column.
Note. The figures indicate thousands of tons. 0 is used where less than 500 tons were produced.

Julius Bien & Co Lith.



The total output of a State is sh
Note. The figures indicate thousands of tons.

HE CENSUS YEAR,
ND KINDS.
LE 7.



e extreme height of its column.
where less than 500 tons were produced.

Julius Bien & Co. Lith.

TABLE 7.—*Iron ore mined in the census year, by states and by kinds.*

[Compare with Plate XIII, and, for totals, with Plate XI.]

States.	Magnetite.	Limonite.	Hematite.	Carbonate.	Fossil.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama		110,696		5,762	75,218	191,676
Connecticut		35,018				35,018
Delaware		2,726				2,726
Georgia		44,210			47,206	91,416
Kentucky		17,660		47,149		64,809
Indiana		513				513
Maine		6,000				6,000
Maryland	218	64,760		73,632	1,018	139,628
Massachusetts		62,637				62,637
Michigan	148,719	*a* 329,897	1,359,096			1,837,712
Missouri		112	386,085			386,197
New Jersey	741,864	15,508				757,372
New York	927,052	154,868	94,765		85,442	1,262,127
North Carolina	2,802	516				3,318
Ohio				547,403		547,403
Oregon		6,972				6,972
Pennsylvania	557,924	1,130,696	15,832	197,374	283,849	2,185,675
Tennessee		27,904			76,561	104,465
Texas		3,600				3,600
Vermont			560			560
Virginia	11,810	129,076	41,440			182,326
West Virginia		3,248		50,968	7,000	61,216
Wisconsin		2,240			39,200	41,440
The United States: Totals	2,390,389	2,148,857	1,897,778	922,288	615,494	7,974,806
The United States: Percentages	29.975	26.945	23.797	11.565	7,717	

a "Soft hematites" (near Negaunee). These ores are more or less hydrated, and are therefore classed for convenience with the limonites, although genetically they belong to the hematites, from which they are derived.

TABLE 8.—*Iron ore mined in the census year, by states and counties and by kinds.*

[Compare with Plates XV to XXI, inclusive.]

State and county.	Fossil.	Carbonate of the Coal Measures and derivatives.	Hematite.	Limonite.	Magnetite.	Total.
ALABAMA.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Bibb				5,670		5,670
Calhoun				27,842		27,842
Cherokee	1,089			31,907		32,996
De Kalb	227					227
Etowah	21,004					21,004
Jefferson	40,213	5,762				45,975
Saint Clair	12,685					12,685
Shelby				25,787		25,787
Talladega				5,338		5,338
Tuscaloosa				14,152		14,152
The state	75,218	5,762		110,696		191,676
CONNECTICUT.						
Litchfield				35,018		35,018
DELAWARE.						
New Castle				2,726		2,726
GEORGIA.						
Bartow				11,353		11,353
Dade	47,206					47,206
Polk				32,857		32,857
The state	47,206			44,210		91,416
KENTUCKY.						
Bath				550		550
Boyd		9,306				9,306
Carter		14,749				14,749
Estill		1,500				1,500
Greenup		20,094				20,094
Lyon				8,505		8,505
Powell		1,500				1,500
Trigg				8,605		8,605
The state		47,149		17,660		64,809

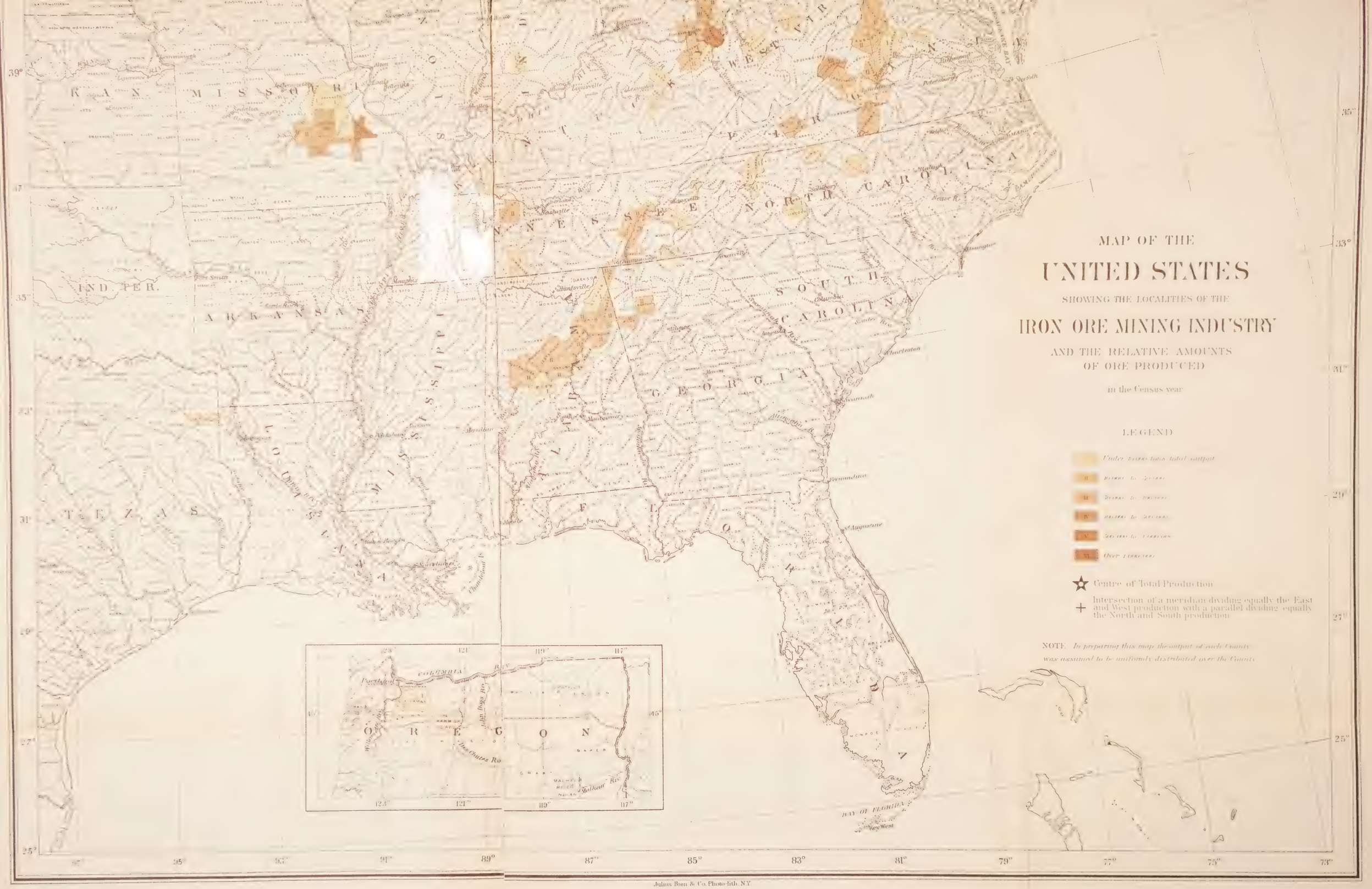
TABLE 8.—*Iron-ore mined in the census year, by states and counties and by kinds*—Continued.

State and county.	Fossil.	Carbonate of the Coal Measures and derivatives.	Hematite.	Limonite.	Magnetite.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
INDIANA.						
Martin				513		513
MAINE.						
Piscataquis				6,000		6,000
MARYLAND.						
Anne Arundel		*a* 6,184				6,184
Alleghany	1,018			3,494		4,512
Baltimore		*a* 40,533		23,309		63,842
Carroll				17,134	218	17,352
Cecil				2,016		2,016
Frederick				18,166		18,166
Harford		*a* 196		81		277
Howard		*a* 14,675				14,675
Montgomery		*a* 25				25
Prince George		*a* 12,019				12,019
Washington				560		560
The state	1,018	73,632		64,760	218	139,628
MASSACHUSETTS.						
Berkshire				62,637		62,637
MICHIGAN.						
Marquette			867,749	329,897	148,719	1,346,365
Menominee			491,347			491,347
The state			1,359,096	329,897	148,719	1,837,712
MISSOURI.						
Crawford			87,033			87,033
Dent			58,878			58,878
Franklin			8,064			8,064
Gasconade			1,120			1,120
Iron			57,297			57,297
Phelps			29,326			29,326
Saint Francois			144,153	112		144,265
Washington			214			214
The state			386,085	112		386,197
NEW JERSEY.						
Bergen					280	280
Hunterdon				1,540	18,086	19,627
Morris				500	567,921	568,420
Passaic					29,166	29,166
Sussex					589,665	589,665
Warren				13,468	36,746	50,214
The state				15,508	741,864	757,372
NEW YORK.						
Essex					631,807	631,807
Clinton					92,166	92,166
Columbia				18,224		18,224
Dutchess				126,654		126,654
Jefferson			64,111			64,111
Oneida	37,052					37,052
Orange				672	90,070	90,742
Putnam					94,117	94,117
Richmond				9,318		9,318
Saint Lawrence			30,654			30,654
Washington					18,892	18,892
Wayne	48,390					48,390
The state	85,442		94,765	154,868	927,052	1,262,127
NORTH CAROLINA.						
Catawba					52	52
Cherokee				516		516
Guilford					1,680	1,680
Lincoln					250	250
Mitchell					720	720
Surry					100	100
The state				516	2,802	3,318

a The carbonate ores of Maryland are not Carboniferous, but as they are the only carbonate ores mined in the census year which are not of that age, they have been placed in this column for the sake of compactness of the table.

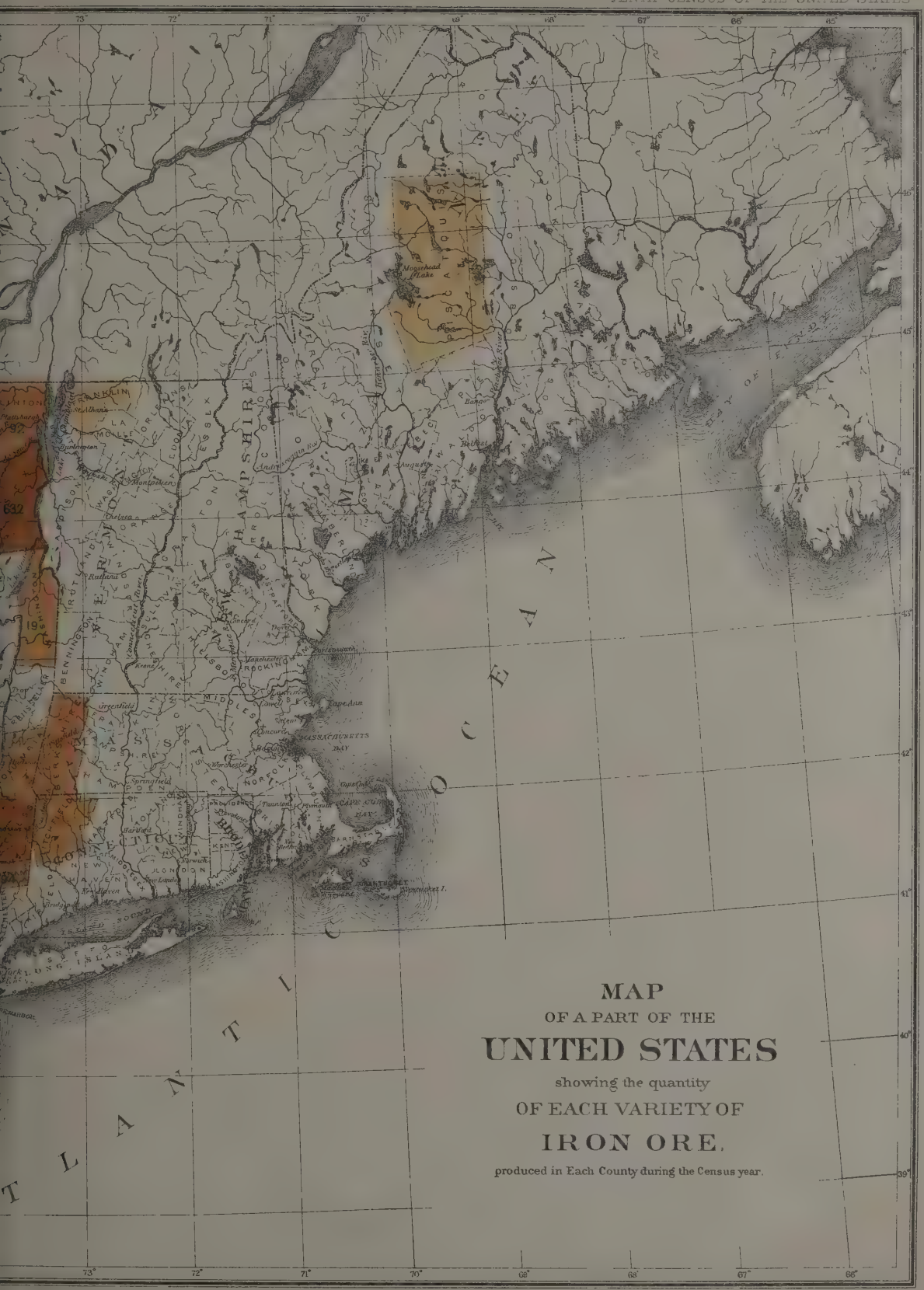
b Including 2,500 tons residue from Franklinite.

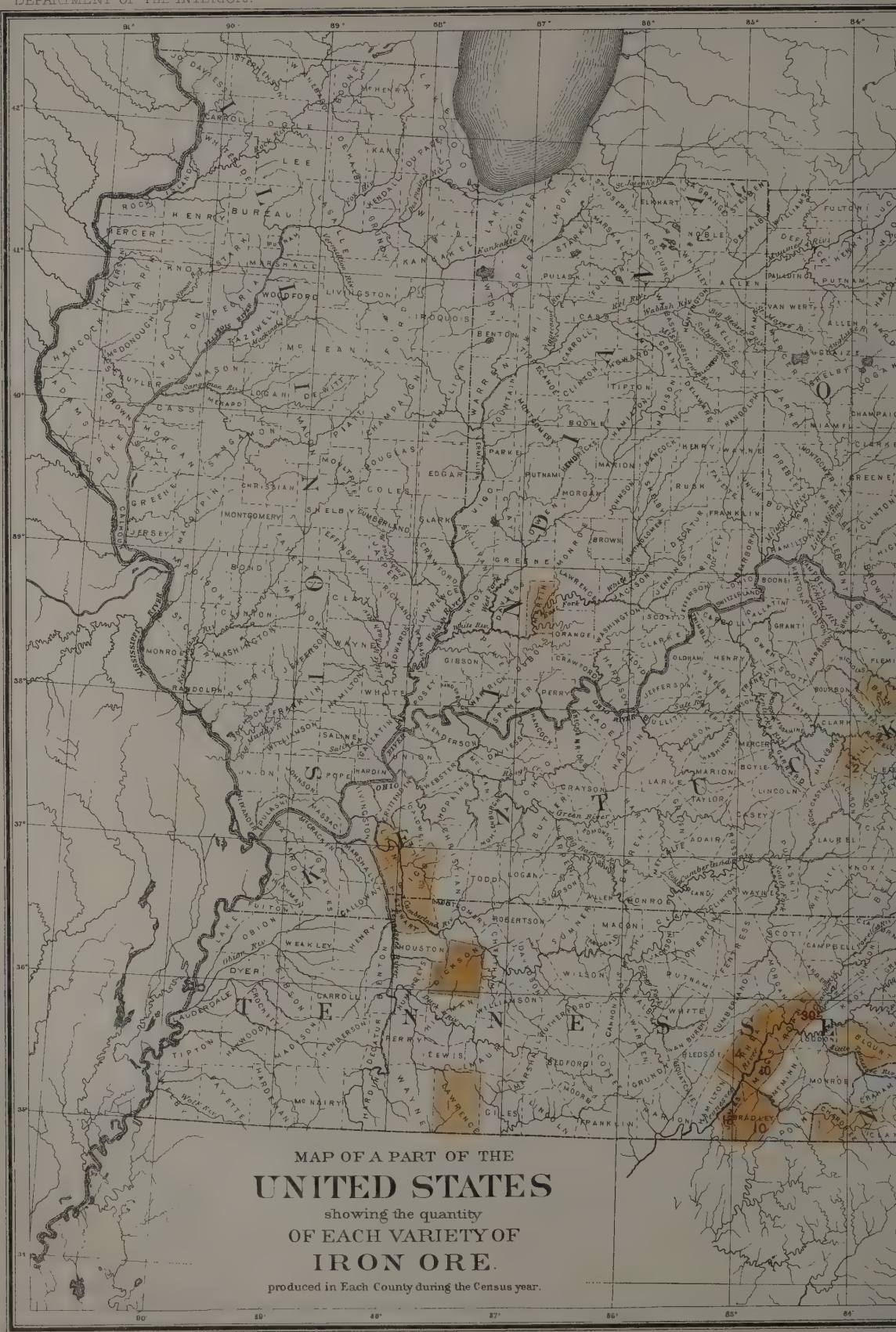
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
GEORGIAN BAY
ST. LAWRENCE RIVER
WISCONSIN
IOWA
NEB.
OHIO
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
MAINE
NEW JERSEY
DELAWARE
Chicago
Milwaukee
Madison
Detroit
Toledo
Cleveland
Buffalo
Albany
Boston
Portland
Pittsburgh
Harrisburg
Philadelphia
Wilkesbarre
Pottsville
Reading
Lancaster
Binghamton
Utica
Rochester
Oswego
Montreal
Quebec
Halifax
Dikes
Nemcke

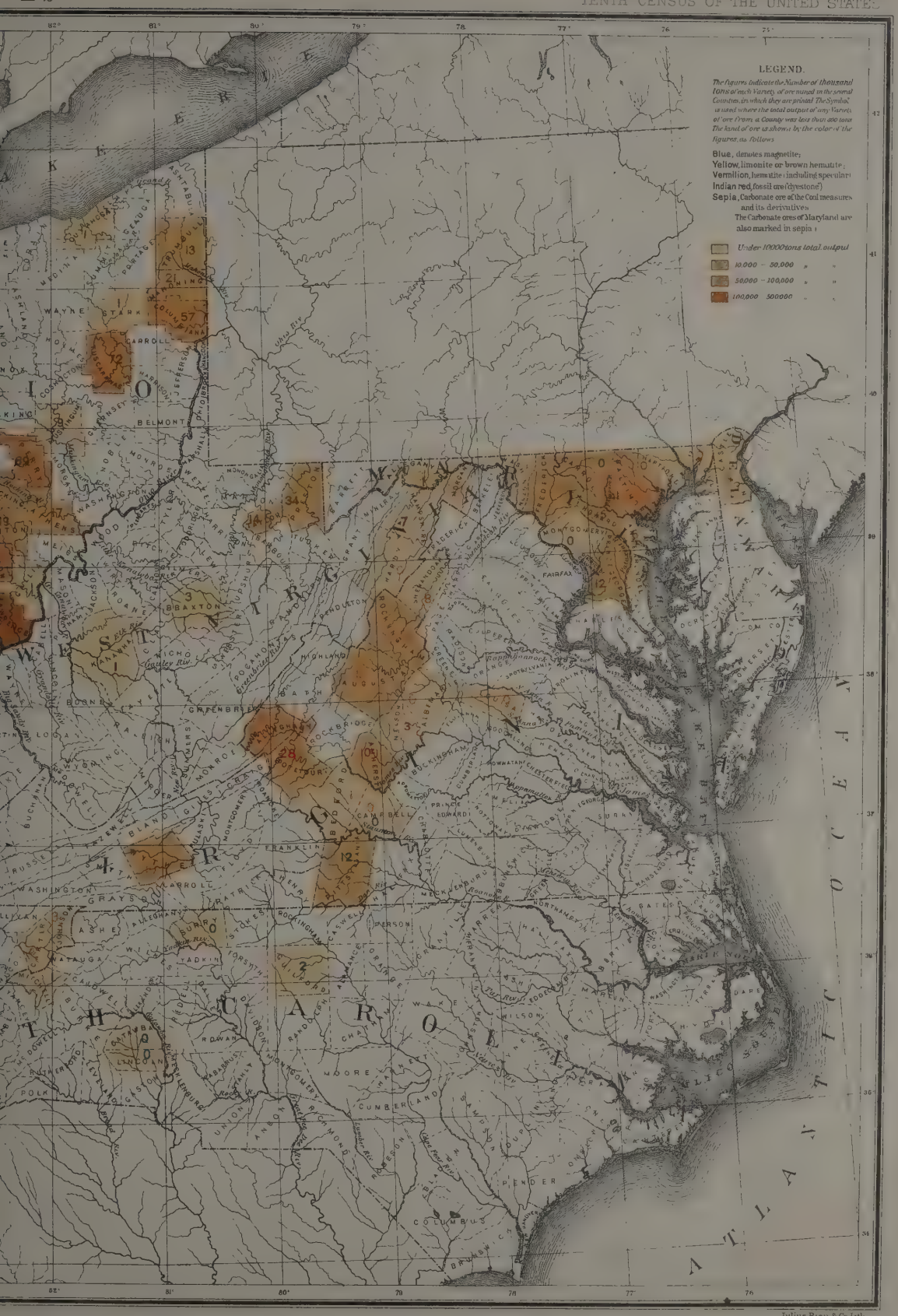

MAP OF THE
UNITED STATES
SHOWING THE LOCALITIES OF THE
IRON ORE MINING INDUSTRY
AND THE RELATIVE AMOUNTS
OF ORE PRODUCED
in the Census year
LEGEND
Under [illegible] tons total output
II [illegible] to [illegible]
III [illegible] to [illegible]
IV [illegible] to [illegible]
V [illegible] to [illegible]
VI Over [illegible]
Centre of Total Production
Intersection of a meridian dividing equally the East and West production with a parallel dividing equally the North and South production
NOTE In preparing this map the output of each County was assumed to be uniformly distributed over the County
KAN.
MISSOURI
IND. TER.
ARKANSAS
TEXAS
LOUISIANA
MISSISSIPPI
TENNESSEE
KENTUCKY
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
ALABAMA
FLORIDA
OREGON
Nashville
Huntsville
Memphis
Louisville
Lexington
Richmond
Petersburg
Norfolk
Raleigh
Salisbury
Charleston
Columbia
Savannah
Montgomery
Mobile
Pensacola
St Augustine
Key West
BAY OF FLORIDA
Portland
COLUMBIA RIV.
Malheur Ri.
Lake Superior
Chattahoochee R.
Neuse R.
Roanoke R.
Tuscaloosa
Alleghany R.
Tallapoosa R.
Alabama R.
Tennessee R.
Cumberland R.
Kanawha R.
Ohio R.
Mississippi R.
Red R.
Arkansas R.
Canadian R.
Cumberland Gap
Pine Bluff
Little Rock
Fort Smith
Lawrence
Leavenworth
Atchison
Boonville
Jefferson City
Hannibal
Keokuk
Dubuque
Chicago
Milwaukee
Detroit
Toledo
Cleveland
Pittsburgh
Wheeling
Baltimore
Washington
Philadelphia
Trenton
Albany
Boston
Hartford
New York
Cincinnati
Indianapolis
Springfield
St Louis
Nashville
Chattanooga
Knoxville
Atlanta
Augusta
Macon
Columbus
Montgomery
Selma
Tuscaloosa
Birmingham
Mobile
New Orleans
Galveston
Houston
Austin
San Antonio
Corpus Christi
Brownsville
Santa Fe
Denver
Salt Lake City
Cheyenne
Omaha
Sioux City
Des Moines
Cedar Rapids
Dubuque
Milwaukee
Green Bay
Marquette
Duluth
St Paul
Minneapolis
Bismarck
Yankton
Sioux Falls
Cheyenne
Denver
Pueblo
Santa Fe
Albuquerque
Tucson
Phoenix
Los Angeles
San Francisco
Sacramento
Portland
Salem
Eugene
Boise City
Salt Lake City
Virginia City
Carson City
Helena
Cheyenne
Denver
Cheyenne
Omaha
Lincoln
Topeka
Wichita
Kansas City
Leavenworth
Fort Smith
Little Rock
Memphis
Nashville
Louisville
Cincinnati
Columbus
Indianapolis
Springfield
St Louis
Jefferson City
Topeka
Lincoln
Omaha
Des Moines
Cedar Rapids
Dubuque
Milwaukee
Chicago
Detroit
Toledo
Cleveland
Pittsburgh
Wheeling
Baltimore
Washington
Philadelphia
Trenton
Albany
Boston
Hartford
New York
Richmond
Raleigh
Charleston
Columbia
Savannah
Atlanta
Montgomery
Mobile
New Orleans
Galveston
Austin

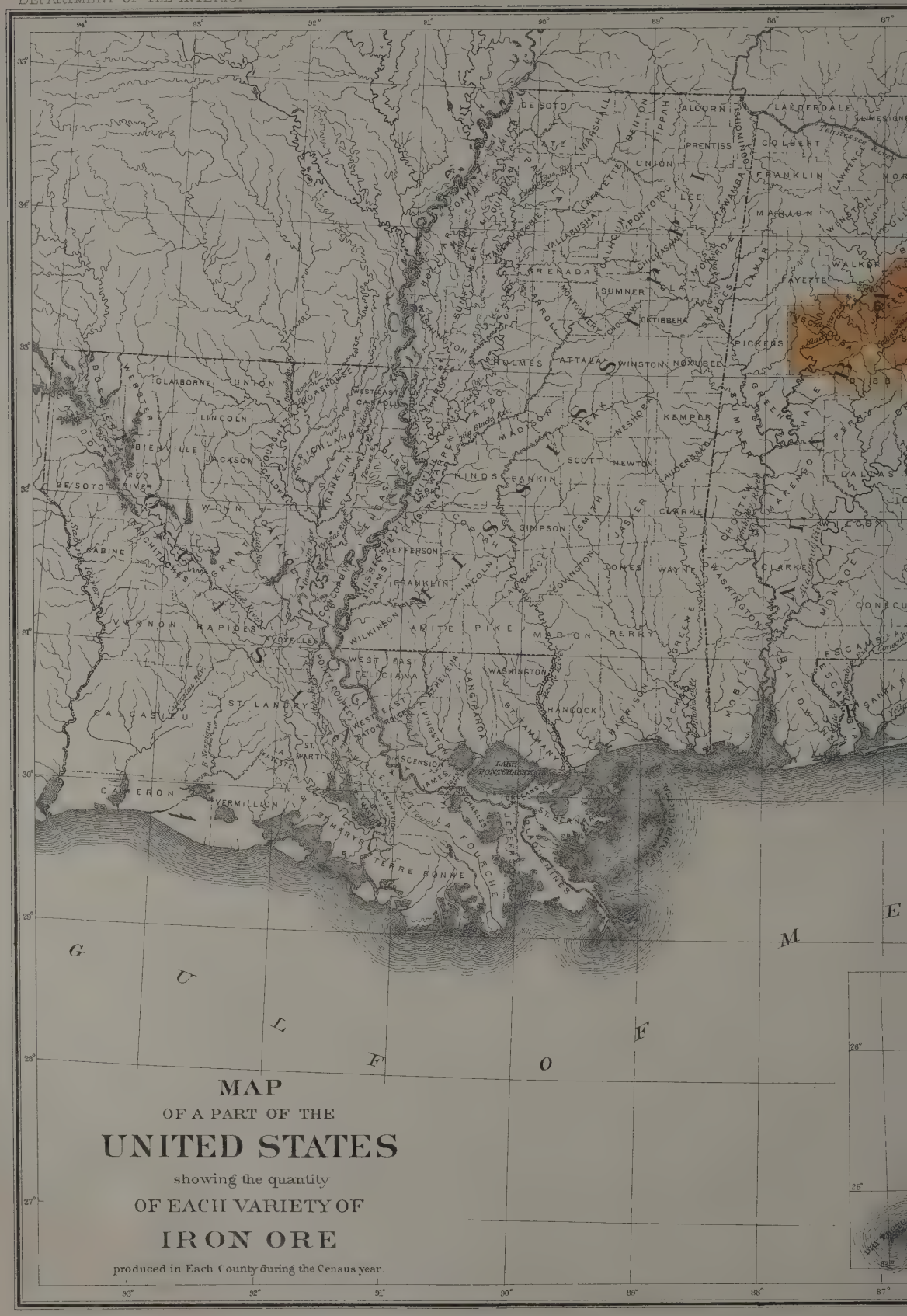
Shee

LEGEND.
The figures indicate the Number of thousand Tons of each Variety of ore mined in the several Counties. In which they are printed. The Symbol 0 is used where the total output of any Variety of ore from a County was less than 500 tons. The kind of ore is shown by the color of the figures, as follows:
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular).
Indian red, fossil ore (ironstone)
Sepia, Carbonate ore of the Coal measures and its derivatives
The Carbonate ores of Maryland are also marked in sepia.)
Under 10,000 tons total output
10,000 – 50,000 " "
50,000 – 100,000 " "
100,000 – 500,000 " "
500,000 – 1,000,000 " "
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
DOMINION OF CANADA
PENNSYLVANIA
NIAGARA
ORLEANS
ERIE
WYOMING
CATTARAUGUS
STEUBEN
TOMPKINS
CHENANGO
DELAWARE
CRAWFORD
WARREN
McKEAN
POTTER
TIOGA
BRADFORD
SULLIVAN
MERCER
BUTLER
CLEARFIELD
CENTRE
LUZERNE
MONROE
WASHINGTON
SOMERSET
GREENE
BERKS
LANCASTER
MONTGOMERY
CUMBERLAND
Buffalo
Rochester
Syracuse
Ithaca
Binghamton
Elmira
Pittsburg
Bedford
Chambersburg
Gettysburg
Reading
Philadelphia
Trenton
Cape May
Ogdensburg
St. Lawrence River
Susquehanna River
Delaware River
Ohio River
Potomac River

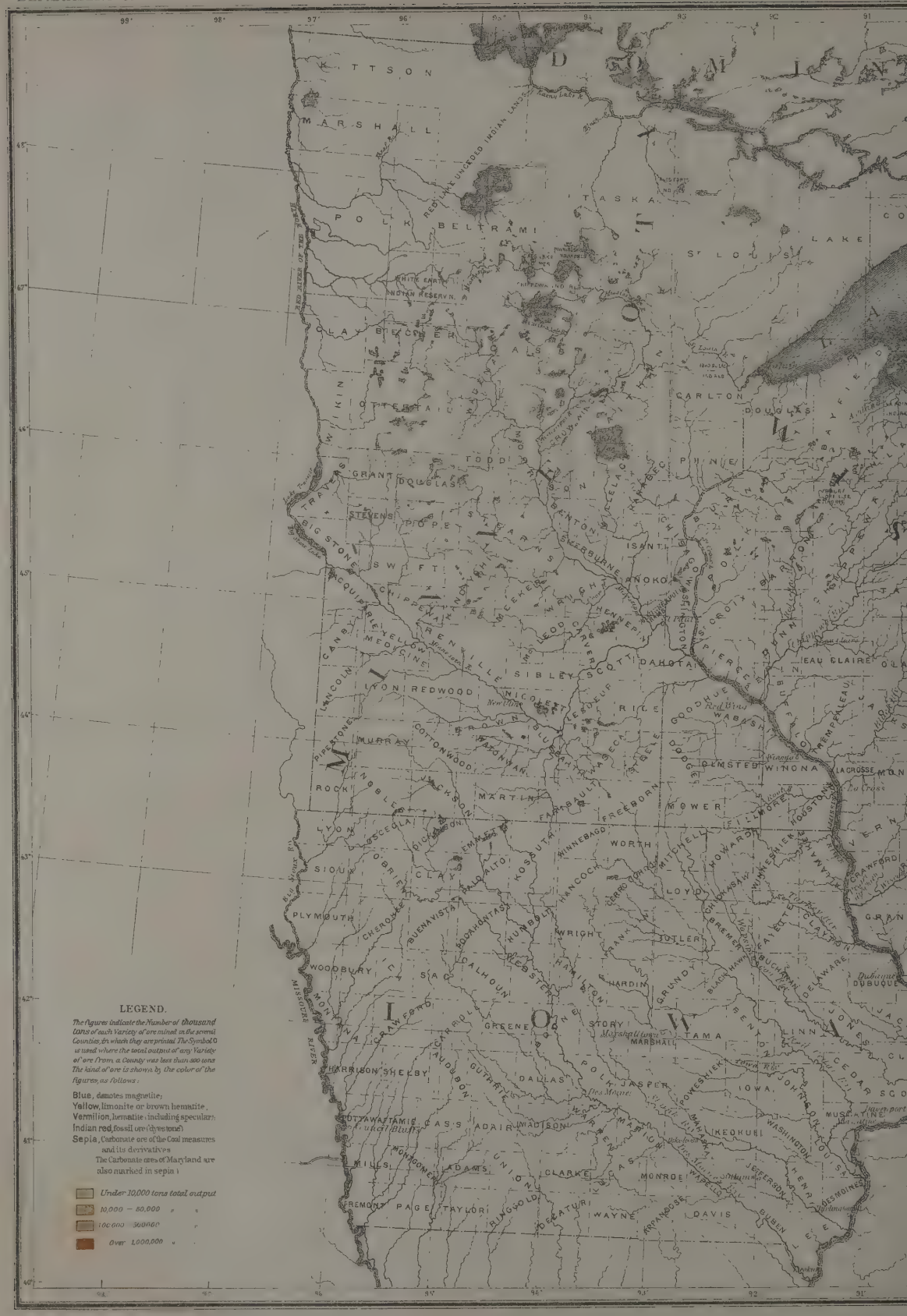

MAP
OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE.
produced in Each County during the Census year.
Moosehead Lake
Cape Ann
Cape Cod Bay
Nantucket I.
Long Island
Atlantic Ocean
Gulf of St. Lawrence
Julius Bien & Co Lith

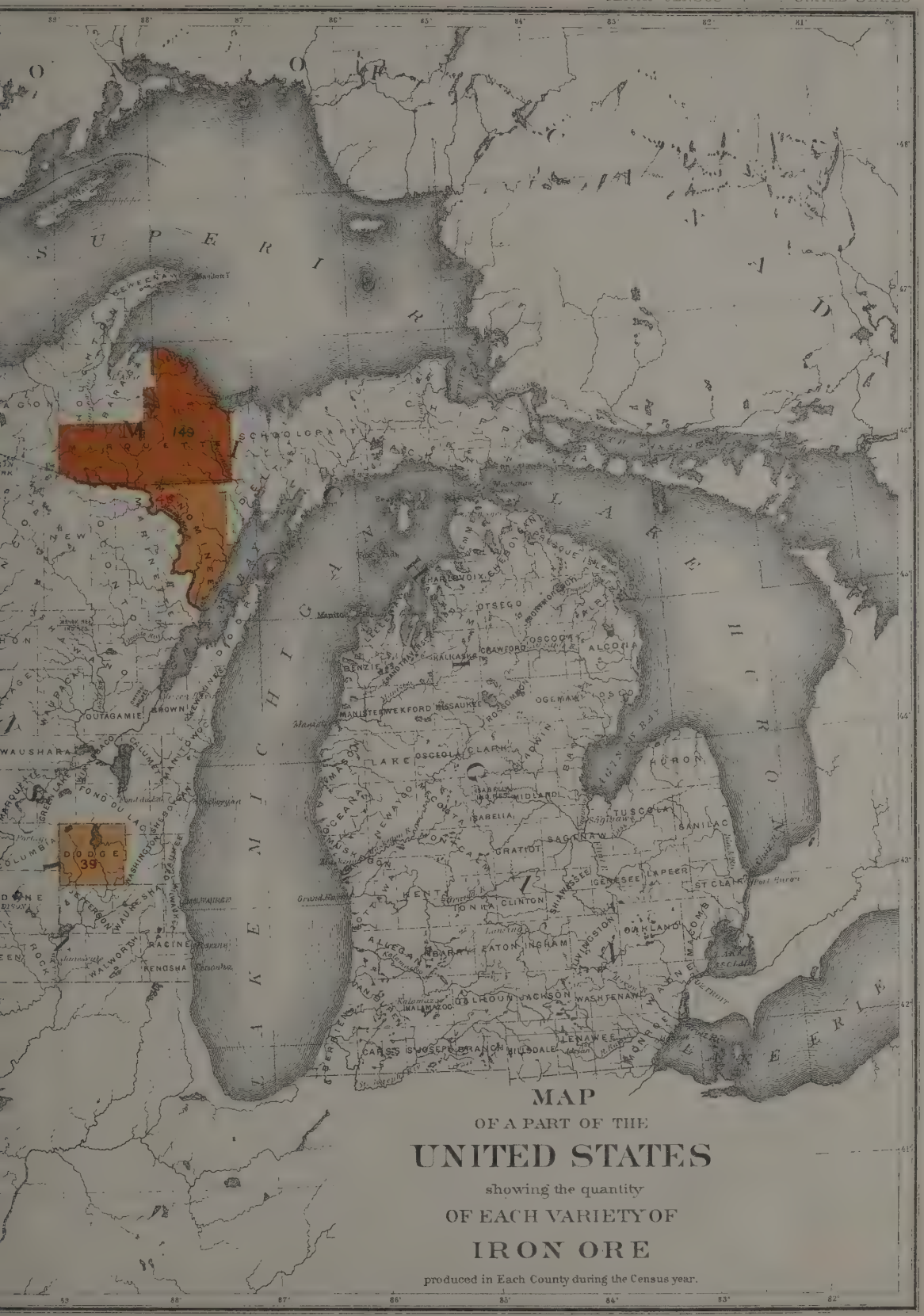

MAP OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE.
produced in Each County during the Census year.

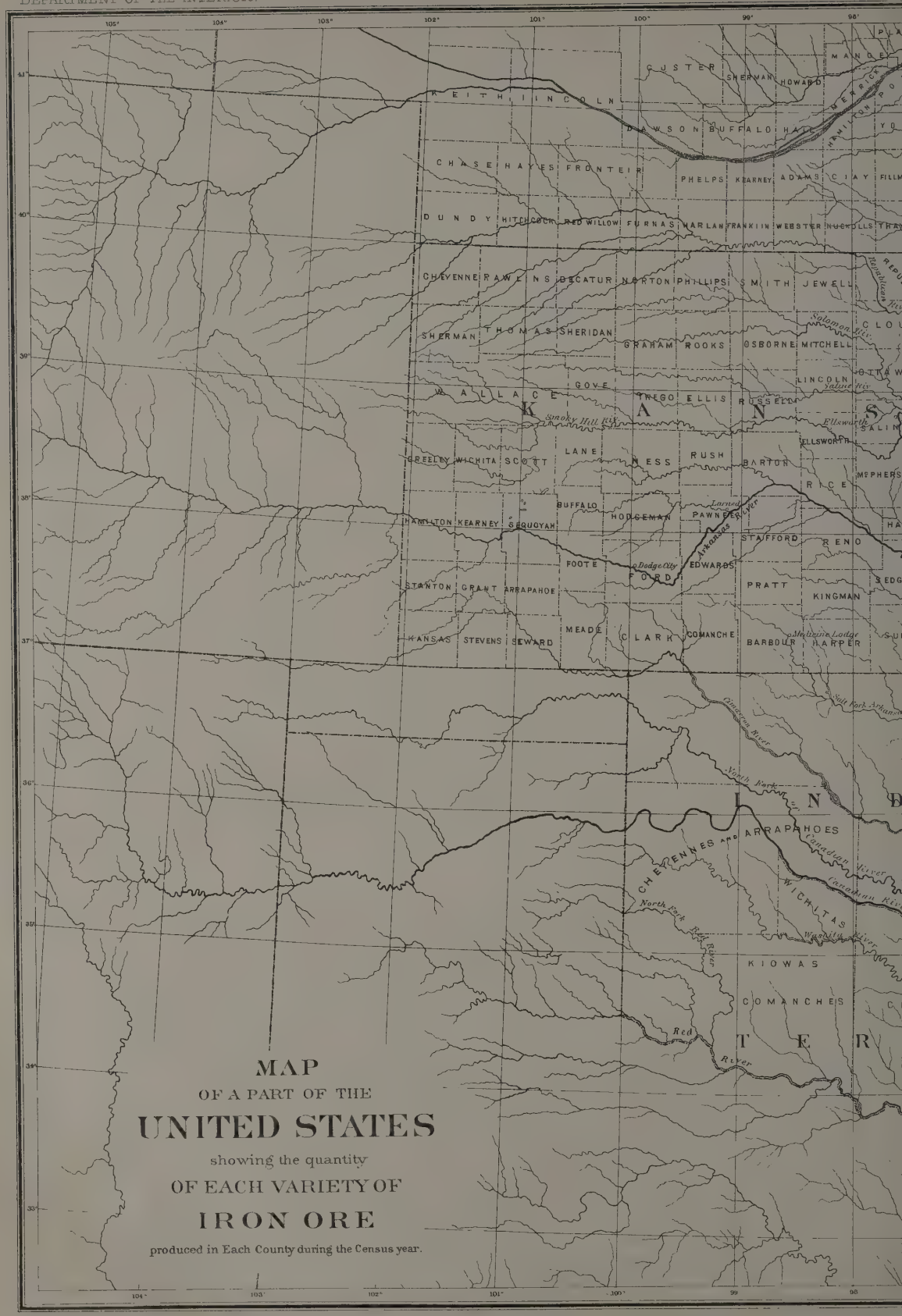

LEGEND.
The figures indicate the Number of thousand tons of each Variety of ore mined in the several Counties in which they are printed. The Symbol is used where the total output of any Variety of ore from a County was less than 500 tons. The kind of ore is shown by the color of the figures, as follows
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular)
Indian red, fossil ore (ryestone)
Sepia, Carbonate ore of the Coal measures and its derivatives
The Carbonate ores of Maryland are also marked in sepia
Under 10000 tons total output
10,000 - 50,000
50,000 - 100,000
100,000 500,000
ATLANTIC OCEAN
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
OHIO
BELMONT
BARBOUR
BRAXTON
GREENBRIER
MONROE
BOTETOURT
ROCKBRIDGE
AUGUSTA
HIGHLAND
BATH
POCAHONTAS
PAGE
FAIRFAX
MONTGOMERY
BUCKINGHAM
CAMPBELL
PRINCE EDWARD
FRANKLIN
PATRICK
HENRY
ROCKINGHAM
PERSON
WASHINGTON
GRAYSON
ASHE
ALLEGHANY
WATAUGA
WILKES
STOKES
ALEXANDER
CATAWBA
LINCOLN
ROWAN
MONTGOMERY
RICHMOND
MOORE
CUMBERLAND
WAKE
WILSON
PITT
PENDER
COLUMBUS
BRUNSWICK
DARE
CURRITUCK
PASQUOTANK
CHOWAN
HYDE
BEAUFORT
MARTIN
BERTIE
HALIFAX
NORTHAMPTON
GREENE
LENOIR
JONES
CRAVEN
PAMLICO
CARTERET
ONSLOW
BLADEN
ROBESON
SCOTLAND
MOORE
CUMBERLAND
HOKE
RICHMOND
ANSON
UNION
MONROE
MECKLENBURG
CABARRUS
STANLY
MONTGOMERY
RANDOLPH
ALAMANCE
ORANGE
CHATHAM
WAKE
WILSON
NASH
EDGECOMBE
PITT
MARTIN
BERTIE
HERTFORD
GATES
PERQUIMANS
PASQUOTANK
CHOWAN
HYDE
DARE
CURRITUCK
BEAUFORT
PAMLICO
CARTERET
ONSLOW
JONES
LENOIR
CRAVEN
GREENE
PITT
WAYNE
DUPLIN
BRUNSWICK
COLUMBUS
BLADEN
ROBESON
SCOTLAND
HOKE
CUMBERLAND
MOORE
RICHMOND
ANSON
UNION
MONROE
MECKLENBURG
CABARRUS
STANLY
MONTGOMERY
RANDOLPH
ALAMANCE
ORANGE
CHATHAM
WAKE
WILSON
NASH
EDGECOMBE
HALIFAX
NORTHAMPTON

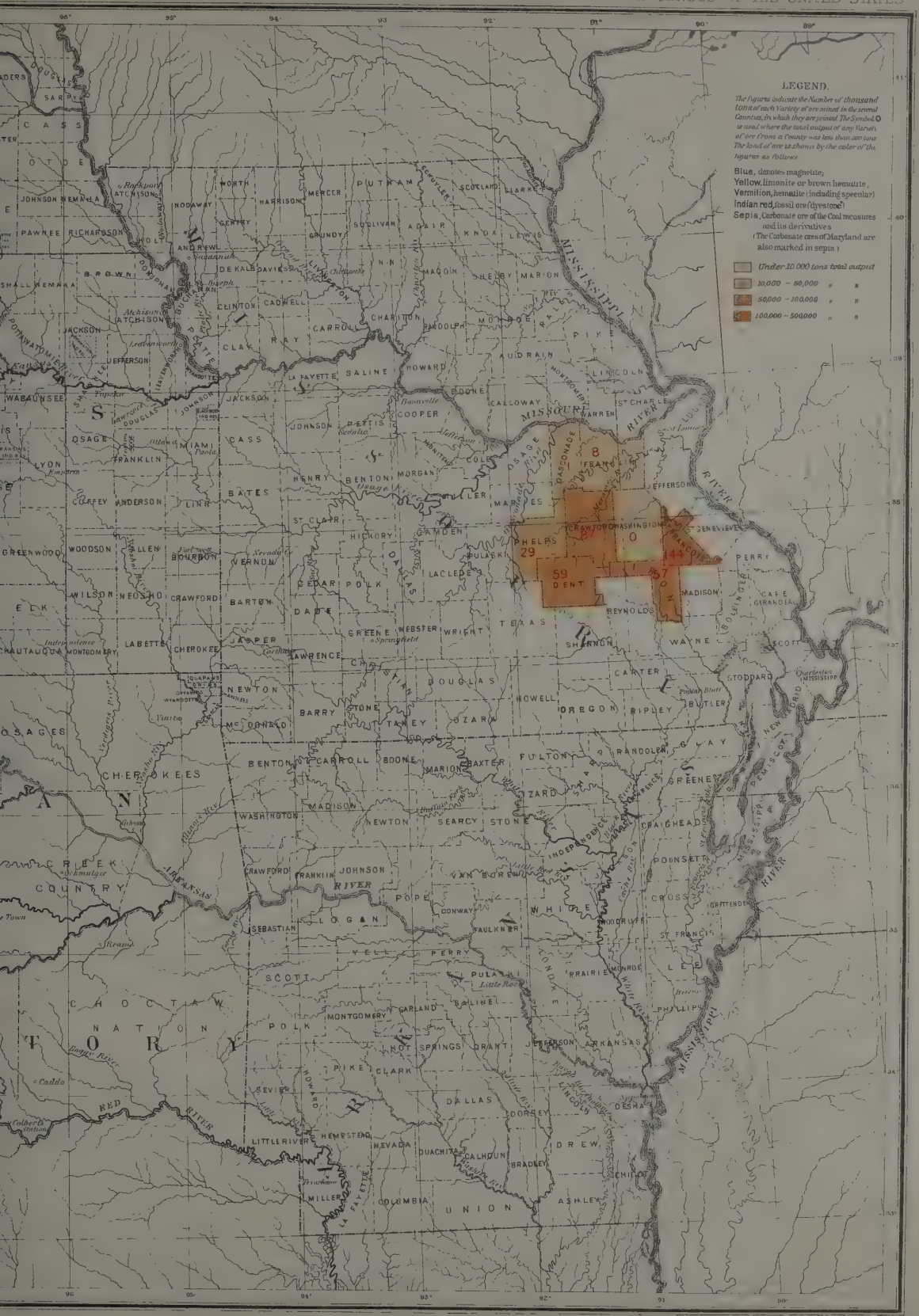

MAP
OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE
produced in Each County during the Census year.
GULF OF MEXICO
DE SOTO
TATE
MARSHALL
BENTON
TIPPAH
ALCORN
LAUDERDALE
PRENTISS
COLBERT
UNION
FRANKLIN
LEE
MONROE
CHICKASAW
GRENADA
SUMNER
FAYETTE
WALKER
OKTIBBEHA
PICKENS
HOLMES
ATTALA
WINSTON
NOXUBEE
CLAIBORNE
UNION
LINCOLN
BIENVILLE
JACKSON
KEMPER
SCOTT
NEWTON
KINDS
FRANKLIN
DE SOTO
WINN
SIMPSON
JASPER
CLARKE
SABINE
JEFFERSON
JONES
WAYNE
VERNON
RAPIDES
AVOYELLES
WILKINSON
AMITE
PIKE
MARION
PERRY
WEST FELICIANA
WASHINGTON
ST LANDRY
HANCOCK
ST MARTIN
ASCENSION
LAKE PONTCHARTRAIN
CAMERON
VERMILLION
ST MARY
TERRE BONNE
ST BERNARD
CONECUH
ESCAMBIA
SANTA

LEGEND.
The figures indicate the Number of thousand tons of each Variety of ore mined in the several Counties, in which they are printed. The Symbol ○ is used where the total output of any Variety of ore from a County was less than 200 tons. The kind of ore is shown by the color of the figures, as follows:
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular);
Indian red, fossil ore (clyestone);
Sepia, Carbonate ores of the Coal measures and its derivatives.
(The Carbonate ores of Maryland are also marked in sepia.)
Under 10,000 tons total output
10,000 — 50,000 " "
SOUTH CAROLINA
GEORGIA
FLORIDA
ATLANTIC OCEAN
GULF OF MEXICO
BAY OF FLORIDA
THE KEYS
THE EVERGLADES
Key West
Tuscaloosa
Chattanooga
Rome
Cartersville
Dalton
Ringgold
Lookout Mt.
Pulaski
Tullahoma
Nashville
Chattanooga
Knoxville
Cumberland Gap
Bristol
Abingdon
Wytheville
Lynchburg
Richmond
Petersburg
Norfolk
Washington
Baltimore
Philadelphia
Harrisburg
Pittsburgh
Wheeling
Cincinnati
Louisville
Frankfort
Lexington
Cairo
Paducah
Memphis
Vicksburg
Natchez
Jackson
Meridian
Mobile
Montgomery
Atlanta
Augusta
Savannah
Charleston
Columbia
Charlotte
Raleigh
Wilmington
Norfolk
Washington
Baltimore
Philadelphia
New York
Boston
Portland
Chicago
Milwaukee
Detroit
Cleveland
Buffalo
Toronto
Quebec
Montreal
Ottawa
Kingston
Halifax
St. John
Bangor
Portland
Boston
Providence
Hartford
New Haven
Albany
Utica
Syracuse
Rochester
Buffalo
Erie
Cleveland
Toledo
Detroit
Lansing
Saginaw
Grand Rapids
Milwaukee
Madison
Green Bay
Chicago
Springfield
Peoria
Quincy
Cairo
St. Louis
Jefferson City
Kansas City
Topeka
Leavenworth
Omaha
Lincoln
Sioux City
Des Moines
Davenport
Dubuque
St. Paul
Duluth
Bismarck
Yankton
Pierre
Cheyenne
Denver
Colorado Springs
Pueblo
Santa Fe
Albuquerque
Salt Lake City
Ogden
Virginia City
Carson City
Sacramento
San Francisco
San Jose
Los Angeles
San Diego
Portland
Salem
Olympia
Seattle
Tacoma
Spokane
Helena
Butte
Boise City
Cheyenne
Denver
Santa Fe
Salt Lake City
Virginia City
Carson City
Sacramento
San Francisco
Los Angeles
San Diego
Portland
Seattle


LEGEND.
The figures indicate the Number of thousand tons of each Variety of ore mined in the several Counties, in which they are printed. The Symbol O is used where the total output of any Variety of ore from a County was less than 500 tons. The kind of ore is shown by the color of the figures, as follows:
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular);
Indian red, fossil ore (dyestone);
Sepia, Carbonate ore of the Coal measures and its derivatives.
The Carbonate ores of Maryland are also marked in sepia.
Under 10,000 tons total output
10,000 — 50,000 "
100,000 — 500,000 "
Over 1,000,000 "
KITTSON
MARSHALL
POLK
BELTRAMI
TASKA
LAKE
ST LOUIS
CLAY
BECKER
CARLTON
DOUGLAS
OTTER TAIL
TODD
GRANT
STEVENS
POPE
SWIFT
ISANTI
KANDIYOHI
MEEKER
SIBLEY
SCOTT
DAKOTA
EAU CLAIRE
LYON
REDWOOD
RICE
MURRAY
COTTONWOOD
WINONA
LACROSSE
ROCK
MARTIN
FREEBORN
MOWER
WORTH
SIOUX
OSCEOLA
DICKINSON
EMMET
KOSSUTH
WINNEBAGO
MITCHELL
HOWARD
CHICKASAW
FAYETTE
CLAYTON
CRAWFORD
PLYMOUTH
CHEROKEE
BUENA VISTA
PALO ALTO
HANCOCK
WRIGHT
BUTLER
BREMER
BUCHANAN
DELAWARE
DUBUQUE
WOODBURY
SAC
CALHOUN
WEBSTER
HARDIN
GRUNDY
BLACK HAWK
STORY
TAMA
MARSHALL
GREENE
HARRISON
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
POWESHIEK
IOWA
JOHNSON
MUSCATINE
OTTAWATTAMIE
CASS
ADAIR
MADISON
KEOKUK
WASHINGTON
MILLS
MONTGOMERY
ADAMS
UNION
CLARKE
MONROE
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
DAVIS
WAPELLO
LEE
MISSOURI RIVER
RED RIVER OF THE NORTH
RED LAKE UNCEDED INDIAN LANDS
WHITE EARTH INDIAN RESERVN.


149
DODGE
39
SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
OTSEGO
CRAWFORD
ALCONA
BENZIE
KALKASKA
OSCODA
OGEMAW
MANISTEE
WEXFORD
MISSAUKEE
OUTAGAMIE
BROWN
WAUSHARA
LAKE
OSCEOLA
CLARE
HURON
MIDLAND
ISABELLA
TUSCOLA
SANILAC
SAGINAW
GRATIOT
GENESEE
LAPEER
ST CLAIR
KENT
IONIA
CLINTON
OAKLAND
ALLEGAN
BARRY
EATON
INGHAM
MACOMB
CALHOUN
JACKSON
WASHTENAW
MONROE
LENAWEE
CASS
ST JOSEPH
BRANCH
HILLSDALE
WALWORTH
RACINE
KENOSHA
WAUKESHA
JEFFERSON
WASHINGTON
FOND DU LAC
COLUMBIA
DANE
MARQUETTE
GREEN LAKE
SCHOOLCRAFT
MARQUETTE
DELTA
MENOMINEE
Marquette
Manistique
Manitou
Grand Haven
Port Huron
Detroit
Toledo
Sandusky
Kenosha
Racine
Milwaukee
Sheboygan
Oshkosh
Green Bay
Escanaba
Menominee
Marinette
Ontonagon
Ashland
Bayfield
Superior
Duluth
Grand Marais
Port Arthur
Fort William
Sault Ste Marie
Mackinaw
Alpena
Saginaw
Bay City
Port Huron
Lake Huron
Lake Michigan
Lake Superior
Lake Erie
Lake Ontario
Lake St Clair
Lake Michigan
Lake Superior
Lake Huron


MAP
OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE
produced in Each County during the Census year.
CUSTER
SHERMAN
HOWARD
KEITH
LINCOLN
DAWSON
BUFFALO
CHASE
HAYES
FRONTIER
PHELPS
KEARNEY
ADAMS
CLAY
DUNDY
HITCHCOCK
RED WILLOW
FURNAS
HARLAN
FRANKLIN
WEBSTER
CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
WALLACE
GOVE
TREGO
ELLIS
RUSSELL
LINCOLN
K A N S
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
ELLSWORTH
RICE
HAMILTON
KEARNEY
SEQUOYAH
BUFFALO
HODGEMAN
PAWNEE
STAFFORD
RENO
FOOTE
EDWARDS
FORD
STANTON
GRANT
ARRAPAHOE
PRATT
KINGMAN
KANSAS
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBOUR
HARPER
Smoky Hill Riv.
Arkansas
Larned
Dodge City
Salomon Riv.
Saline Riv.
Ellsworth
Cimarron River
North Fork
Canadian River
CHEYENNES AND ARRAPAHOES
WICHITAS
North Fork
Red River
KIOWAS
COMANCHES
Red River
I N D I A N T E R



Julius Bien & Co Lith

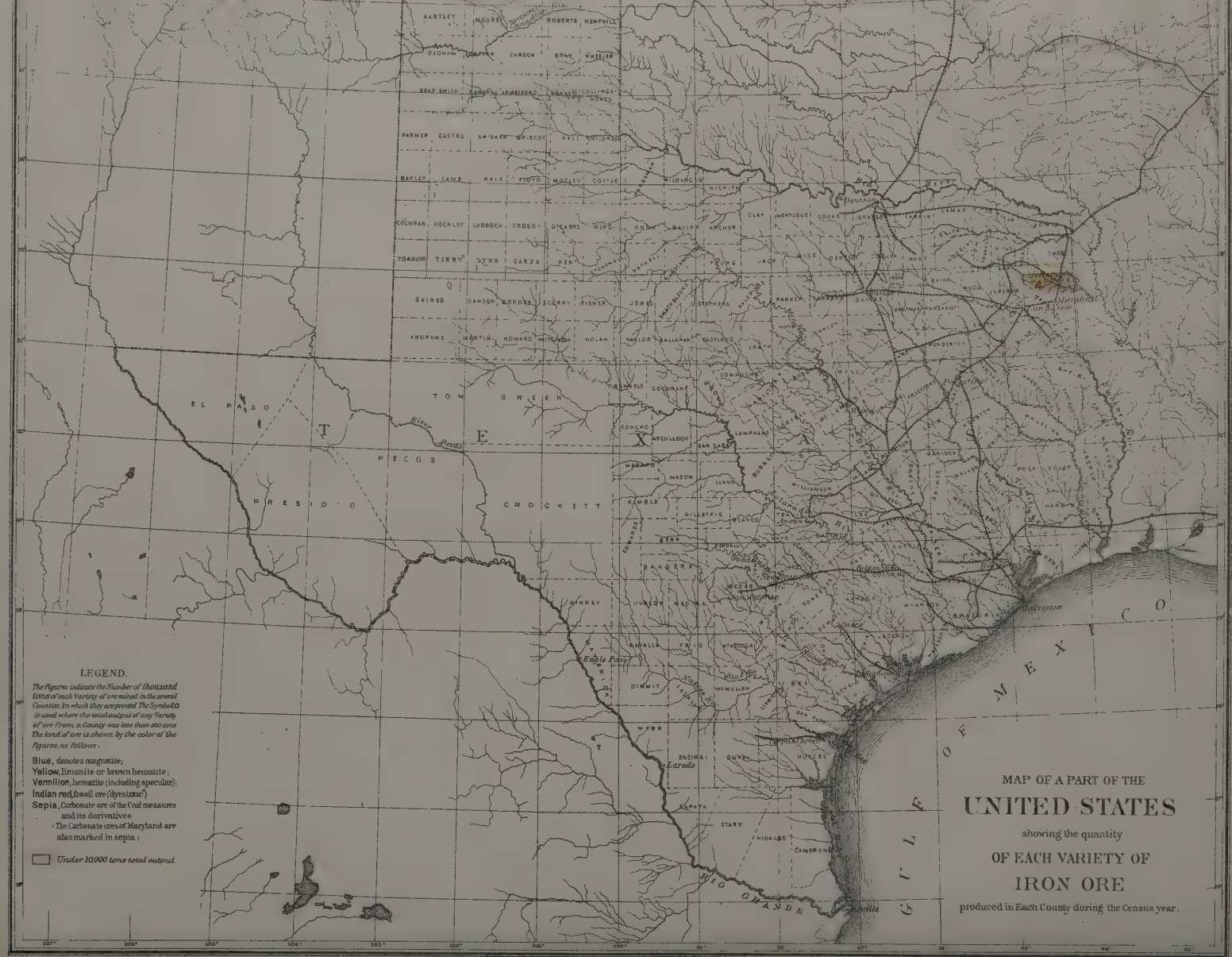

MAP OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE
produced in Each County during the Census year.
LEGEND.
The figures indicate the Number of thousand tons of each Variety of ore mined in the several Counties. In which they are printed. The Symbol ⊙ is used where the total output of any Variety of ore from a County was less than 200 tons. The kind of ore is shown by the color of the figures, as follows:
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular);
Indian red, fossil ore (dyestone);
Sepia, Carbonate ore of the Coal measures and its derivatives
(The Carbonate ores of Maryland are also marked in sepia.)
Under 10000 tons total output.
Scale.
Eagle Pass
Laredo
Galveston
Rio Grande
Pecos River
Gulf of Mexico
Julius Bien & Co. Lith.

PLATE XX.

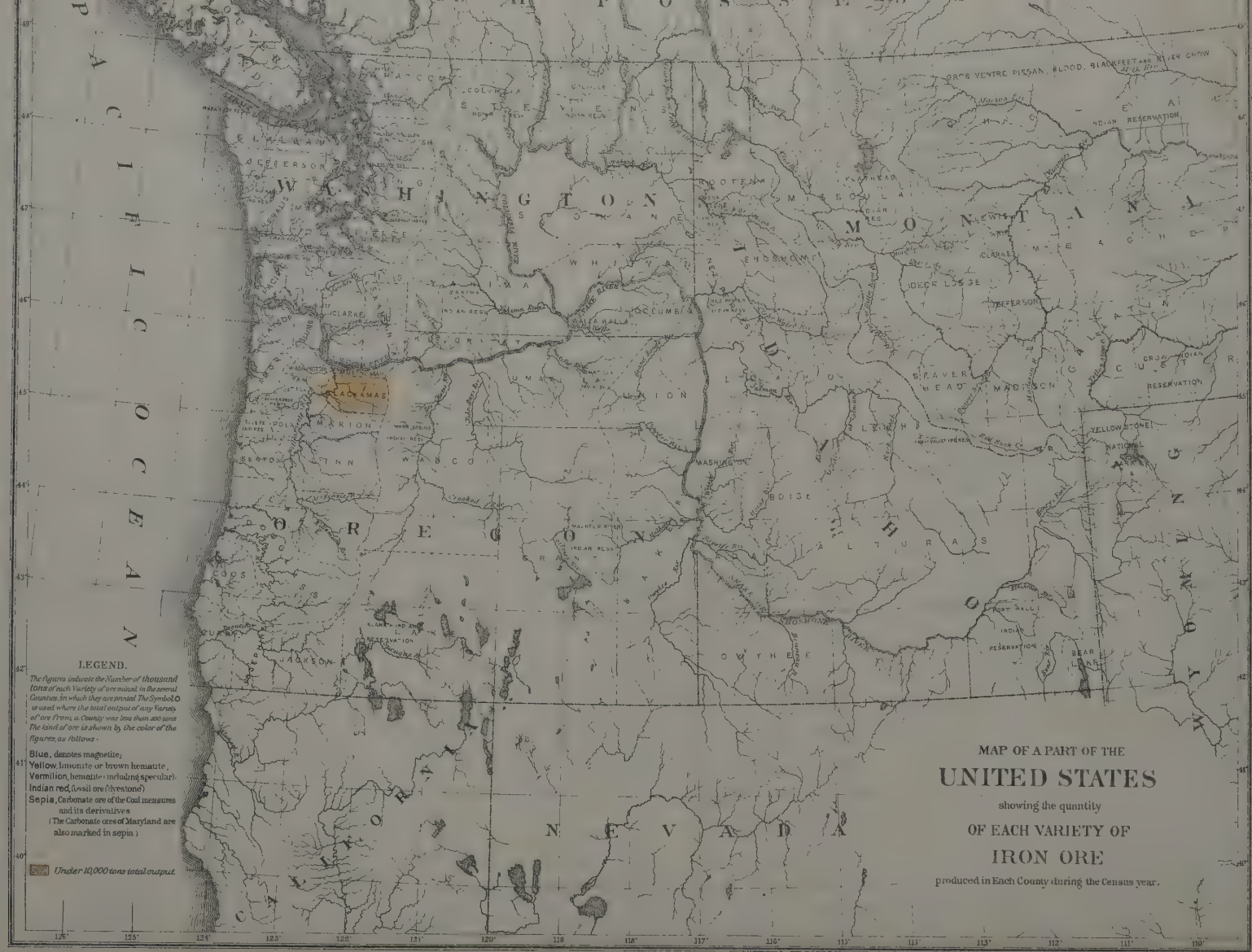

MAP OF A PART OF THE
UNITED STATES
showing the quantity
OF EACH VARIETY OF
IRON ORE
produced in Each County during the Census year.
LEGEND.
The figures indicate the Number of thousand tons of each Variety of ore mined in the several Counties in which they are printed. The Symbol ○ is used where the total output of any Variety of ore from a County was less than 100 tons. The kind of ore is shown by the color of the figures, as follows:
Blue, denotes magnetite;
Yellow, limonite or brown hematite;
Vermilion, hematite (including specular);
Indian red, (fossil ore "flyestone")
Sepia, Carbonate ore of the Coal measures and its derivatives
(The Carbonate ores of Maryland are also marked in sepia.)
Under 10,000 tons total output.
PACIFIC OCEAN
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEBRASKA
SOUTH DAKOTA
NORTH DAKOTA
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
CLACKAMAS
MARION
UNION
WASHINGTON
BOISE
OWYHEE
JEFFERSON
CLARKE
COLUMBIA
YELLOWSTONE NATIONAL PARK
INDIAN RESERVATION
Scale
25 50 75 MILES
Julius Bien & Co. lith.

PLATE XXI

TABLE 8.—*Iron ore mined in the census year, by states and counties and by kinds*—Continued.

State and county.	Fossil.	Carbonate of the Coal Measures and derivatives.	Hematite.	Limonite.	Magnetite.	Total.
OHIO.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Athens		17,000				17,000
Columbiana		56,949				56,949
Cuyahoga		1,224				1,224
Gallia		680				680
Hocking		40,740				40,740
Jackson		73,423				73,423
Lawrence		136,464				136,464
Mahoning		20,636				20,636
Muskingum		8,654				8,654
Perry		69,373				69,373
Scioto		17,837				17,837
Stark		500				500
Trumbull		12,735				12,735
Tuscarawas		72,388				72,388
Vinton		18,800				18,800
The state		547,403				547,403
OREGON.						
Clackamas				6,972		6,972
PENNSYLVANIA.						
Adams				560		560
Allegheny		350				350
Armstrong		31,557				31,557
Bedford	37,369					37,369
Berks				159,074	145,880	304,954
Blair	40,636			114,278		154,914
Bucks					24,192	24,192
Butler		2,318				2,318
Carbon				852		852
Centre				8,935		8,935
Chester				5,031	9,006	14,037
Clarion		15,705				15,705
Columbia	22,588					22,588
Cumberland				75,915		75,915
Dauphin			1,120	1,956	56	3,132
Fayette		76,140				76,140
Franklin				36,558	56	36,614
Huntingdon	15,927			10,186		26,113
Juniata	35,729					35,729
Lancaster				78,850		78,850
Lawrence		70,296				70,296
Lebanon				5,629	280,000	285,629
Lehigh				349,302	70,398	419,700
Lycoming	5,374					5,374
Mercer		1,008				1,008
Mifflin	29,333			24,366		53,699
Montgomery				94,387		94,387
Montour	33,890					33,890
Northampton				121,794	732	122,526
Northumberland	4,164			1,978		6,142
Perry	26,650			12,734		39,384
Snyder	31,426					31,426
Tioga	100					100
Union	663			146		809
York			14,712	28,165	27,604	70,058
The state	283,849	197,374	15,832	1,130,696	557,924	2,185,675
TENNESSEE.						
Blount				2,342		2,342
Bradley	9,931					9,931
Carter				4,445		4,445
Dickson				10,773		10,773
Hamblen				5,600		5,600
James	13,235					13,235
Johnson				3,060		3,060
Lawrence				641		641
Meigs	10,206					10,206
Rhea	13,608					13,608
Roane	29,581					29,581
Stewart				1,043		1,043
The state	76,561			27,904		104,465

TABLE 8.—*Iron ore mined in the census year, by states and counties and by kinds*—Continued.

State and county.	Fossil.	Carbonate of the Coal Measures and derivatives.	Hematite.	Limonite.	Magnetite.	Total.
TEXAS.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Marion				3,600		3,600
VERMONT.						
Franklin			560			560
VIRGINIA.						
Albemarle				53		53
Alleghany				61,106		61,106
Amherst			10,080	560		10,640
Augusta				16,762		16,762
Bedford				500		500
Botetourt			28,000	225		28,225
Campbell				224	84	308
Louisa				14		14
Nelson			3,360			3,360
Pittsylvania					11,726	11,726
Rockingham				31,360		31,360
Shenandoah				7,856		7,856
Wythe				10,416		10,416
The state			41,440	129,076	11,810	182,326
WEST VIRGINIA.						
Braxton		2,500				2,500
Hampshire	7,000					7,000
Hardy				448		448
Kanawha		845				845
Morgan				2,800		2,800
Preston		33,825				33,825
Taylor		13,798				13,798
The state	7,000	50,968		3,248		61,216
WISCONSIN.						
Dodge	39,200					39,200
Sauk				2,240		2,240
The state	39,200			2,240		41,440
The United States	615,494	922,288	1,897,778	2,148,857	2,390,389	7,974,806

TABLE 9.—*Iron ore mined in the census year (a) by kinds of ore and its per cent. of metallic iron, and (b) by kinds of ore and the amount of its contained iron.*

[Compare with Plate XXII.]

MAGNETITE.

	Tons of ore.		Tons of iron.
Under 45 per cent., say 43 per cent	336,867	× 43 per cent. =	144,853
45 to 60 per cent., say 53 per cent	1,239,770	× 53 per cent. =	657,078
Over 60 per cent., say 63 per cent	813,752	× 63 per cent. =	512,663
Total	2,390,389		1,314,594

LIMONITE.

Under 40 per cent., say 38 per cent	393,551	× 38 per cent. =	149,549
40 to 50 per cent., say 45 per cent	1,082,344	× 45 per cent. =	487,055
Over 50 per cent., say 53 per cent	672,962	× 53 per cent. =	356,670
Total	2,148,857		993,274

HEMATITE.

Under 45 per cent., say 43 per cent	86,937	× 43 per cent. =	37,383
45 to 60 per cent., say 55 per cent	569,364	× 55 per cent. =	313,150
Over 60 per cent., say 63 per cent	1,241,477	× 63 per cent. =	782,130
Total	1,897,778		1,132,663

CARBONATE AND DERIVATIVES.

Under 35 per cent., say 33 per cent	254,777	× 33 per cent. =	84,076
Over 35 per cent., say 40 per cent	667,511	× 40 per cent. =	267,004
Total	922,288		351,080

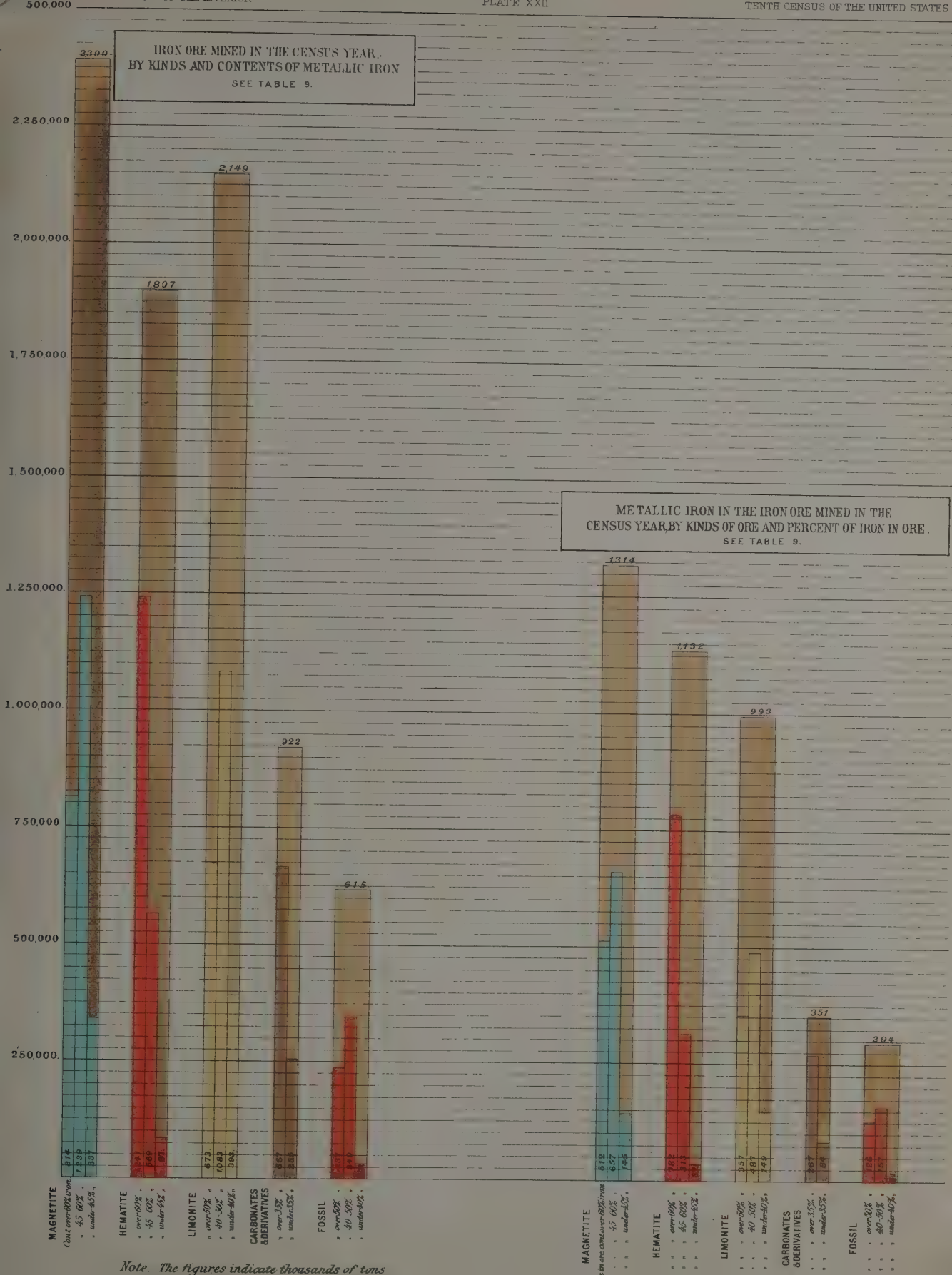

IRON ORE MINED IN THE CENSUS YEAR, BY KINDS AND CONTENTS OF METALLIC IRON
SEE TABLE 9.
METALLIC IRON IN THE IRON ORE MINED IN THE CENSUS YEAR, BY KINDS OF ORE AND PERCENT OF IRON IN ORE.
SEE TABLE 9.
500,000
2,250,000
2,000,000
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
2390
1897
2,149
922
615
1314
1132
993
351
294
MAGNETITE
HEMATITE
LIMONITE
CARBONATES & DERIVATIVES
FOSSIL
Note. The figures indicate thousands of tons

TABLE 9.—*Iron ore mined in the census year (a) by kinds of ore and its per cent. of metallic iron, and (b) by kinds of* a *ore and the amount of its contained iron*—Continued.

FOSSIL.

Under 40 per cent., say 38 per cent	29,121 × 38 per cent. =	11,066
40 to 50 per cent., say 45 per cent	349,208 × 45 per cent. =	157,144
Over 50 per cent., say 53 per cent	237,165 × 53 per cent. =	125,697
Total	615,494	293,907
Grand total	7,974,806	4,085,518

This gives an average per cent. of metallic iron in all the ore mined in the census year equal to 51.22. b

In Mr. Swank's report on the statistics of the iron and steel production of the United States it is stated that there were produced from blast-furnaces 3,781,021 tons of pig-iron and castings from 7,256,684 tons of ore, which would show an average yield of the ore of 52.13 per cent. of iron.

PLATE XXII AND TABLE 9.

From the columns on the left half of this plate we learn that of the three grades of magnetite the largest product was of ore of the middle grade, containing 45 to 60 per cent. iron, and next in the highest grade; but there were mined over 336,867 tons of magnetite containing less than 45 per cent. of iron.

On the other hand, among the hematites the larger product was in the highest grade, over 60 per cent. iron, and within 2,000 tons of the largest magnetite tonnage, which was, as above stated, in the middle grade, 45 to 60 per cent. iron, while only a small amount (87,000 tons) of hematite was mined of the lowest grade, viz, under c 45 per cent. of iron. The reason for this difference between the low-grade magnetite and low-grade hematite doubtless lies largely in the fact that the latter are more silicious and refractory than the former.

Again, in the limonite column, we find in its middle grade (40 to 50 per cent. iron) the largest tonnage, and a much larger product of its low grade (under 40 per cent. iron) than that of the lowest grade hematite. The advantage thus possessed by the lower grades of the hydrated ores is doubtless due in part to the fact that part of their impurity is water, which is much more cheaply got rid of than silica, and in part to the fact that their impurity being largely of aluminous constituents, they work to advantage with silicious ore.

The columns on the right hand show the relative amounts of metallic iron in tons contributed to the metallic-iron product of the United States in the census year by the different varieties of ore.

These amounts are obtained by multiplying tonnage by the percentage of metallic iron, as determined by our d own analysis of the commercial and differential samples taken by our own experts.

From these columns it appears that while the largest amount of iron was contributed by the three grades of magnetite, the largest amount contributed among all the varieties by any one grade came from the richest hematite, carrying over 60 per cent. iron.

A comparison of these columns with those of plate XII will show very strikingly the overwhelming importance of the older formations as contributors, nearly six-sevenths of the metallic iron having come from the Archæan and Siluro-Cambrian deposits, while three-fifths came from the Archæan alone.

A similar comparison, when made for the production of 1890, will probably show that the dominant contributor will be the hematite of the Huronian, and that the "fossil" ores will contribute more than the carbonates.

e

TABLE 10.—*Iron ore mined in the census year, by its per cent. of metallic iron, by kinds, and by states.*

[NOTE.—The figures in bold-faced type indicate tons of ore from mines from which no samples have been analyzed. The classification in such cases was based on the general character of the ore of the region. The amount of this estimated product is in each case *included* in the amount indicated by the common-faced figures that stand directly under the bold-faced ones. For instance, Alabama is credited with 5,762 tons of carbonate ore containing less than 35 per cent. of metallic iron. The mines that produced 4,082 (5,762–1,680) tons of this were sampled, and the classification of their product is based upon the analyses of the samples. No samples were taken, however, from the mines from which 1,680 tons of ore was raised, and the classification of this portion of the product is based simply on the known general character of similar ore from the region. Again, although many samples of the carbonate ores of Ohio and Maryland, were analyzed, as these ores are mined from small openings along almost continuous outcrops, it was not practicable to identify the analyses with definite amounts of ore mined in the census year. The classification of such ores was based upon their general character as shown by the analyses. Of the total product of 7,974,806 tons, 5,629,003 tons are classified from analyses of ore from producing mines, and 2,345,803 tons are classified from the general character of similar known ore.]

States.	MAGNETITE.			LIMONITE.			HEMATITE.			CARBONATE.		FOSSIL.			Total.
	Under 45 per cent.	45 to 60 per cent.	Over 60 per cent.	Under 40 per cent.	40 to 50 per cent.	Over 50 per cent.	Under 45 per cent.	45 to 60 per cent.	Over 60 per cent.	Under 35 per cent.	Over 35 per cent.	Under 40 per cent.	40 to 50 per cent.	Over 50 per cent.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama					28,293	82,403				1,680 5,762			227 12,912	62,306	191,676
Connecticut					34,878	140									35,018
Delaware				2,054	672										2,726
Georgia					**15,000** 18,584	**3,849** 25,626								**47,206** 47,206	91,416
Indiana					**513** 513										513
Kentucky					17,660					**2,088** 6,624	**2,090** 40,525				64,809
Maine					6,000										6,000
Maryland			218		**64,760** 64,760						**73,632** 73,632		1,018		139,628

TABLE 10.—*Iron ore mined in the census year, by its per cent. of metallic iron, by kinds, and by states*—Continued.

States.	MAGNETITE.			LIMONITE.			HEMATITE.			CARBONATE.		FOSSIL.			Total.
	Under 45 per cent.	45 to 60 per cent.	Over 60 per cent.	Under 40 per cent.	40 to 50 per cent.	Over 50 per cent.	Under 45 per cent.	45 to 60 per cent.	Over 60 per cent.	Under 35 per cent.	Over 35 per cent.	Under 40 per cent.	40 to 50 per cent.	Over 50 per cent.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Massachusetts	.....	.....	.....	.....	5,600 62,637	.....	.....	.....	.....	.....	.....	.....	.....	.....	62,637
Michigan	.....	.....	148,719	.....	14,157	60,425 315,740	.....	7,701 360,283	33,600 998,813	.....	.....	.....	.....	.....	1,837,712
Missouri	.....	.....	.....	.....	112 112	.....	.....	143,981	242,104	.....	.....	.....	.....	.....	386,197
New Jersey	78,400	41,512 517,201	146,263	.....	5,637 15,508	.....	.....	.....	.....	.....	.....	.....	.....	.....	757,372
New York	130,425	26,274 290,047	506,580	14,149	1,824 140,719	.....	55,577	255 39,188	.....	.....	.....	280	85,162	.....	1,262,127
North Carolina	100	290 2,022	680	.....	.....	404 516	.....	.....	.....	.....	.....	.....	.....	.....	3,318
Ohio	.....	.....	.....	.....	.....	.....	.....	.....	.....	107,276 107,276	440,127 440,127	.....	.....	.....	547,403
Oregon	.....	.....	.....	.....	6,972	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,972
Pennsylvania	127,942	127,399 429,982	.....	303,732 374,649	341,513 552,473	158,395 203,574	.....	15,832 15,832	.....	94,325 109,631	74,456 87,743	22,338 28,841	173,672 225,838	10,121 29,170	2,185,675
Tennessee	.....	.....	.....	1,130	11,893	2,458 14,881	.....	.....	.....	.....	.....	.....	5,684 17,278	5,684 59,283	104,465
Texas	.....	.....	.....	.....	3,600 3,600	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,600
Vermont	.....	.....	.....	.....	.....	.....	.....	.....	560 560	.....	.....	.....	.....	.....	560
Virginia	.....	518 518	11,292	1,569	97,425	30,082	31,360	10,080	.....	.....	.....	.....	.....	.....	182,326
West Virginia	.....	.....	.....	.....	3,248 3,248	.....	.....	.....	.....	25,484 25,484	25,484 25,484	.....	7,000 7,000	.....	61,216
Wisconsin	.....	.....	.....	.....	2,240 2,240	.....	.....	.....	.....	.....	.....	.....	.....	39,200	41,440
The United States	336,867	195,993 1,239,770	813,752	303,732 393,551	444,045 1,082,344	225,511 672,962	86,937	23,788 569,364	33,760 1,241,477	230,853 254,777	615,789 667,511	22,338 29,121	186,583 349,208	63,011 237,165	2,345,803 7,974,866

TABLE 10 *a*.—*Metallic iron in the ore mined in the census year, by states, kinds of ore and its per cent. in metallic iron.*

State.	METALLIC IRON IN MAGNETITE.			METALLIC IRON IN LIMONITE.			METALLIC IRON IN HEMATITE.			METALLIC IRON IN CARBONATE.		METALLIC IRON IN FOSSIL ORE.			Total.	Per cent.
	In ore containing under 45 per cent. iron, say 43 per cent.	In ore containing from 45 to 60 per cent. iron, say 53 per cent.	In ore containing over 60 per cent. iron, say 63 per cent.	In ore containing under 40 per cent. iron, say 38 per cent.	In ore containing from 40 to 50 per cent. iron, say 45 per cent.	In ore containing over 50 per cent. iron, say 53 per cent.	In ore containing under 45 per cent. iron, say 43 per cent.	In ore containing from 45 to 60 per cent. iron, say 55 per cent.	In ore containing over 60 per cent. iron, say 63 per cent.	In ore containing under 35 per cent. iron, say 33 per cent.	In ore containing over 35 per cent. iron, say 40 per cent.	In ore containing under 40 per cent. iron, say 38 per cent.	In ore containing from 40 to 50 per cent. iron, say 45 per cent.	In ore containing over 50 per cent. iron, say 53 per cent.		
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
Alabama	.....	.....	.....	.....	12,732	43,674	.....	.....	.....	1,901	.....	.....	5,810	33,022	97,139	2.378
Connecticut	.....	.....	.....	.....	15,695	74	.....	.....	.....	.....	.....	.....	.....	.....	15,769	0.388
Delaware	.....	.....	.....	780	302	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,082	0.026
Georgia	.....	.....	.....	.....	8,363	13,582	.....	.....	.....	.....	.....	.....	.....	25,019	46,964	1.149
Indiana	.....	.....	.....	.....	231	.....	.....	.....	.....	.....	.....	.....	.....	.....	231	0.005
Kentucky	.....	.....	.....	.....	7,947	.....	.....	.....	.....	2,186	16,210	.....	.....	.....	26,343	0.645
Maine	.....	.....	.....	.....	2,700	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,700	0.066
Maryland	.....	.....	137	.....	29,142	.....	.....	.....	.....	.....	29,453	.....	458	.....	59,190	1.449
Massachusetts	.....	.....	.....	.....	28,187	.....	.....	.....	.....	.....	.....	.....	.....	.....	28,187	0.690
Michigan	.....	.....	93,693	.....	6,371	167,342	.....	198,156	629,252	.....	.....	.....	.....	.....	1,094,814	26.797
Missouri	.....	.....	.....	.....	50	.....	.....	79,190	152,526	.....	.....	.....	.....	.....	231,766	5.674
New Jersey	33,712	274,116	92,146	.....	6,979	.....	.....	.....	.....	.....	.....	.....	.....	.....	406,953	9.960
New York	56,083	153,725	319,145	5,377	63,324	.....	23,898	21,553	.....	.....	.....	106	38,323	.....	681,534	16.681
North Carolina	45	1,072	428	.....	.....	273	.....	.....	.....	.....	.....	.....	.....	.....	1,816	0.044
Ohio	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,401	176,051	.....	.....	.....	211,452	5.178
Oregon	.....	.....	.....	.....	3,137	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,137	0.077
Pennsylvania	55,015	227,890	.....	142,367	248,613	107,894	.....	8,707	.....	36,178	35,097	10,960	101,628	15,460	989,809	24.227
Tennessee	.....	.....	.....	429	5,352	7,887	.....	.....	.....	.....	.....	.....	7,775	31,420	52,863	1.294
Texas	.....	.....	.....	.....	1,620	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,620	0.040
Vermont	.....	.....	.....	.....	.....	.....	.....	.....	352	.....	.....	.....	.....	.....	352	0.006
Virginia	.....	275	7,114	596	46,841	15,944	13,485	5,544	.....	.....	.....	.....	.....	.....	86,799	2.125
West Virginia	.....	.....	.....	.....	1,461	.....	.....	.....	.....	8,410	10,193	.....	3,150	.....	23,214	0.568
Wisconsin	.....	.....	.....	.....	1,008	.....	.....	.....	.....	.....	.....	.....	.....	20,776	21,784	0.533
The United States	144,853	657,078	512,663	149,549	487,055	356,670	37,383	313,150	782,130	84,076	267,004	11,066	157,144	125,697	4,085,518	.....
Per cent.	3.545	16.083	12.548	3.661	11.921	8.731	0.915	7.666	19.143	2.058	6.536	0.271	3.846	3.076	.....	100.000

TABLES 10 AND 10*a* AND PLATE XIII.

Tables 10 and 10*a* show for each state the kinds and the grades of the ores mined, and the number of tons of metallic iron contributed by each grade.

The varied resources of Pennsylvania are shown by the fact that each of the five great varieties—magnetite, hematite, limonite, carbonate, and fossil ore—contributed to her product. While we see from plate XIII that the limonite furnished the largest amount of ore, and the magnetite the next largest, we see from table 10*a* that the largest contribution of metallic iron was from the middle grade of limonite, carrying from 40 to 50 per cent. iron; and the next largest amount was from the middle grade of magnetite, containing 45 to 60 per cent. iron. Only the middle grade of hematite is represented, and while the two grades of carbonate and derivatives contributed almost equal amounts, the middle grade of fossil ore—40 to 50 per cent. iron—furnished nearly four times as much iron as the highest and lowest grades combined.

In New Jersey it is the middle grade—45 to 60 per cent.—magnetites that furnishes the greater amount of iron, while in New York, whose center of production is much more distant from market, the magnetite of the highest grade ranks first as an iron producer.

Looking at the fossil ores, we find that while in Pennsylvania, New York, and West Virginia the middle grade—40 to 50 per cent. iron—is the largest contributor (New York furnished no fossil ore of the highest grade, and Pennsylvania only a small fraction), in the States of Alabama, Georgia, Tennessee, and Wisconsin the production was almost confined to the highest grade—over 50 per cent. iron.

Looking at the carbonates, we find that of the whole amount of iron from this source three-fourths came from the higher grade—over 35 per cent. iron.

In the hematites only New York and Virginia produced ores averaging below 45 per cent. iron, and only Michigan and Missouri mined hematites averaging above 60 per cent.

TABLE 11.—*A partial classification of the iron ore mined in the census year, by phosphorus ratios, by kinds, and by states.*

States.	MAGNETITE.					LIMONITE.					HEMATITE.				
Phosphorus ratio	Under .05	.05–.10	.10–.50	.50–1.00	Over 1.00	Under .05	.05–.10	.10–.50	.50–1.00	Over 1.00	Under .05	.05–.10	.10–.50	.50–1.00	Over 1.00
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama								57,867	24,358	28,471					
Connecticut								34,878		140					
Delaware								672	2,054						
Georgia									7,504	17,857					
Indiana															
Kentucky								17,660							
Maine						6,000									
Maryland			218					26,789	17,843	17,133					
Massachusetts								55,389	1,368	280					
Michigan		47,300	99,419				80,055	189,417			187,896	633,338	488,481	8,080	
Missouri											11,146	276,834	88,562		
New Jersey	11,087	103,754	176,763	176,200	232,548				9,871						
New York	184,649	151,367	40,557	102,824	421,381		24,805	82,556	41,552	4,131			70,586	8,534	15,390
North Carolina	2,400	350				112									
Ohio															
Oregon										6,972					
Pennsylvania	300,213	88,935	60,598			3,290	55,936	85,953	72,093	97,355					
Tennessee							5,600	17,659	1,963	224					
Texas															
Virginia			11,292				2,800	58,920	29,924	35,840		3,360	10,080	28,000	
Vermont															
West Virginia									448						
Wisconsin															
The United States	498,349	391,706	388,847	279,024	653,929	9,402	169,196	627,760	208,978	208,403	199,042	913,532	657,709	44,614	15,390
Total classified					2,211,855					1,223,739					1,830,287
Total unclassified					178,534					925,678					66,931
Total product					2,390,389					2,149,417					1,897,218

a TABLE 11.—*A partial classification of the iron ore mined in the census year, by phosphorus ratios, &c.*—Continued.

States.	COAL-MEASURE AND MESOZOIC CARBONATES AND DERIVATIVES.					FOSSIL.					Total ore, classified.	Total ore, unclassified.	Total product.
Phosphorus ratio	Under .05	.05–.10	.10–.50	.50–1.00	Over 1.00	Under .05	.05–.10	.10–.50	.50–1.00	Over 1.00			
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Alabama								41, 302	33, 689		185, 687	5, 989	191, 676
Connecticut											35, 018		35, 018
Delaware											2, 726		2, 726
Georgia											25, 361	66, 055	91, 416
Indiana												513	513
Kentucky			9, 381	6, 036	1, 500						34, 577	30, 232	64, 809
Maine											6, 000		6, 000
Maryland			73, 368					1, 018			136, 369	3, 259	139, 628
Massachusetts											57, 037	5, 600	62, 637
Michigan											1, 733, 986	103, 726	1, 837, 712
Missouri											376, 542	9, 655	386, 197
New Jersey											710, 223	47, 149	757, 372
New York										85, 442	1, 233, 774	28, 353	1, 262, 127
North Carolina											2, 862	456	3, 318
Ohio												547, 403	547, 403
Oregon											6, 972		6, 972
Pennsylvania			12, 287	15, 306				14, 013	54, 142	41, 361	901, 482	1, 284, 193	2, 185, 675
Tennessee								23, 166	28, 294	13, 732	90, 638	13, 827	104, 465
Texas												3, 600	3, 600
Virginia											180, 216	2, 110	182, 326
Vermont												560	560
West Virginia								7, 000			7, 448	53, 768	61, 216
Wisconsin										39, 200	39, 200	2, 240	41, 440
The United States			95, 036	21, 342	1, 500			86, 499	116, 125	179, 735			
Total classified					117, 878					382, 359			
Total unclassified					804, 410					233, 135			
Total product					922, 288					615, 494	5, 766, 118	2, 208, 688	7, 974, 806

d TABLE 11.

This table deals only with a part of the product of the country—something less than three-quarters, and with more than five-sixths of the ore from the Bessemer producing varieties—magnetite, hematite, and limonite.

In view of the tendency of the metallurgical requirements of the near future, the columns showing tonnage with a phosphorus ratio of under .05 and of over 1.00 become equally interested with the acid-Bessemer columns proper, namely, under .05 and .05 to .10.

An interesting fact is, that while the magnetites produced only about four-fifths as much Bessemer ore as the hematites, more than half of the magnetite contribution of Bessemer ore had the extremely low phosphorus ratio of under .05; and the magnetite tonnage with this low ratio was more than double that of the hematite, with a
e similarly low ratio.

TABLE 12.—*Bessemer ore mined in the census year, by kinds and by states.*

[Compare with plates XXIII and XXIV.]

[NOTE.—In this table is included only such ore that if smelted alone would produce pig containing not more than one-tenth of one per cent. of phosphorus. It is to be noted, however, that ore with a higher phosphorus-iron ratio than 0.10 is used in mixture in the manufacture of Bessemer pig.]

States.	Magnetite.	Hematite.	Limonite.	Total.	Per cent.
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Maine			6, 000	6, 000	.28
Michigan	47, 300	821, 234	a80, 055	948, 589	43.47
Missouri		b287, 980		287, 980	13.20
New Jersey	114, 841			114, 841	5.26
New York	336, 016		24, 805	360, 821	16.55
North Carolina	2, 750		112	2, 862	.13
Pennsylvania	389, 148		c59, 226	448, 374	20.56
Tennessee			5, 600	5, 600	.26
Virginia		3, 360	2, 800	6, 160	.28
Total	890, 055	1, 112, 574	178, 598	2, 181, 227	
Per cent	40.81	51.01	8.18	100.00	100.00

a See note under table 7. (Production of ore by states and kinds.)

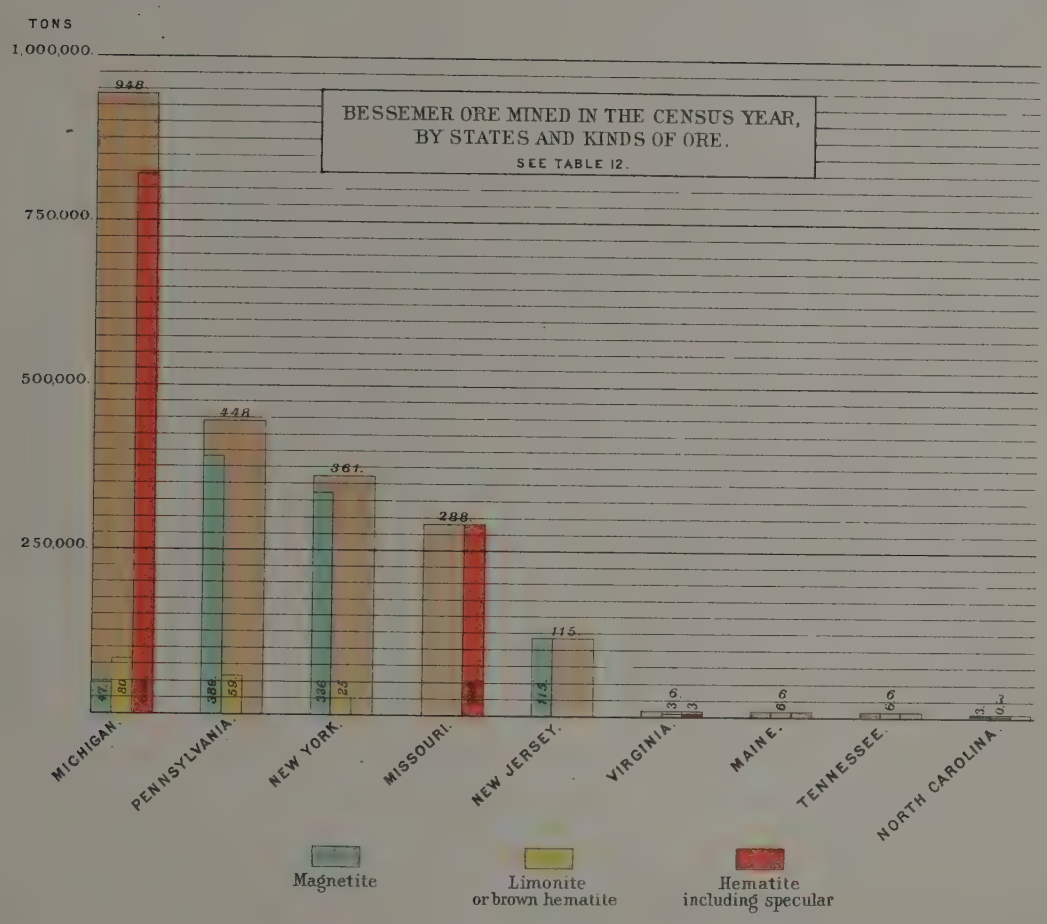
b In making up the total Bessemer-ore product of Missouri, it was assumed that all but 500 tons of the ore mined at Iron Mountain in the census year was sufficiently low in phosphorus to come into this class.

c This is a rough estimate only. It is probably below the truth, even for ore with a phosphorus ratio less than 0.10 per cent. As a matter of fact, the tota product of the Bloomfield and Springfield mines in Blair county (107,222 tons) is reported as having been used, mixed with magnetite ore, to make Bessemer pig, while only that from the Springfield mines (53,739 tons) is shown by analysis to have a phosphorus ratio less than 0.10 per cent., and is included in this table.

BESSEMER ORE PRODUCT IN THE CENSUS YEAR

See Table 12

Julius Bien & Co. Lith.



Note. The figures indicate thousands of tons. 0 is used where less than 500 tons were produced.

Julius Bien & Co. Lith.

TABLES 11 AND 12 AND PLATES XXIII AND XXIV.

a

Among the most important tabulations are the tables and plates presenting the production of Bessemer ore, or ore having a phosphorus-iron ratio not exceeding 0.10. The total Bessemer product—2,181,227 tons—formed 27.35 per cent. of the total ore product of the United States.

Nine states produced more or less, although four of these furnished each less than one-third of one per cent. of the whole.

Their order as to amount of Bessemer ore mined is shown on the table on page 19. Michigan ranks first, producing 43 per cent. of the national product, and more than twice as much as the next largest state, Pennsylvania, which furnished 20½ per cent.; while New York followed third with 16½ per cent., and Missouri fourth with 13⅕ per cent., and New Jersey fifth with 5¼ per cent. b

From table 12 and plate XXIII we see that only three of the great varieties—magnetite, hematite, and limonite—contributed ore with a sufficiently low phosphorus ratio, to be applicable without mixture to the manufacture of Bessemer steel. Of the total tonnage of 2,181,227 tons, the different varieties gave—

Ores.	Tons.	Per cent.
Magnetite	890,055	40.81
Hematite	1,112,574	51.01
Limonite	178,598	8.18
Total	2,181,227	100.00

c

Referring these ores to their geological sources we find that the Huronian is by far the largest contributor, the Laurentian coming next, and the Siluro-Cambrian third, a large part of the Bessemer of the latter formation being the magnetites of the Cornwall and other mines, which are assigned by Lesley to that horizon as altered limonites.

The actual geological distribution of the Bessemer product is as follows:

Ores.	Tons.	Per cent.
Laurentian	482,611	22.13
Huronian	1,242,841	56.98
Siluro-Cambrian	449,775	20.62
Cenozoic	6,000	0.27
Total	2,181,227	100.00

d

The southern states produced all together only 14,622 tons, or less than $\frac{67}{100}$ of 1 per cent. This may be materially changed by future development of ore-bodies in the Archæan regions of North and South Carolina and Georgia.

There were produced of ores with a phosphorus ratio of under .05—

Ores.	Tons.
Magnetite	498,349
Hematite	199,042
Limonite	9,402
Total	706,793

e

or nearly one-eleventh of the total ore product of the country.

Out of the 5,766,118 tons of ore designated in table 11, as "classified" by our chemical analyses, there were of ores carrying more than 1 per cent. of phosphorus—

Ores.	Tons.	Per cent. of the classified ore of this variety.
Magnetite	653,929	27.56
Hematite	15,390	0.84
Limonite	208,403	17.02
Carbonate	1,500	1,27
Fossil	179,735	47.00
Total	1,058,957	.....

f

We may assume, probably without appreciable error, that in the unclassified portions of magnetite, hematite, limonite, and fossil ores, the percentages of ores with a phosphorus-iron ratio greater than 1.00 will be the same as they are in the classified portions of those varieties. This assumption cannot be made, however, for the carbonates, as, for reasons elsewhere stated, no attempt was made to classify as regards phosphorus-iron ratio the greater part of the Coal Measure ores. The samples of these ores were taken to represent, not mines, but fields.

a An examination of the tables of analyses shows, however, that of the 93 samples from Ohio, 31, or one-third, gave a phosphorus-iron ratio greater than 1.00. The same fraction represents the proportion of the Alabama and Kentucky carbonate samples carrying this proportion of phosphorus.

It is believed, therefore, that we will not be far from the truth if we estimate one-third of the total carbonate product as having a phophorous-iron ratio greater than 1.00.

We should have, then, in our unclassified ores, the following amounts of ores with a phosphorus-iron ratio greater than 1.00:

b

Ores.	Tons.
Magnetite	52,775
Hematite	562
Limonite	157,550
Carbonate	305,500
Fossil	109,573
Total	625,960
Ore previously classified as above	1,058,957
Total ore having a phosphorus-iron ratio greater than 1.00.	1,684,917

Although not strictly belonging in this place, I have added a table showing the maximum, minimum, and

c average royalty paid in each state for the privilege of mining each kind of ore. Royalty was paid on more than one-quarter of the product of the United States, the average being 43.7 cents per ton of 2,000 pounds.

Mr. I. Lowthian Bell (*a*) states that the usual royalty paid in England to the landowners for hematite and calcined blackband is about 2*s*. 6*d*., or 62½ cents per ton of 2,240 pounds, though in some instances much more is paid. In the Cleveland district, where the ore is leaner and the amount of ore is practically inexhaustible, it is rated (1884) at 9 per cent. of the selling price of Cleveland pig-iron. Mr. Bell summarizes roughly the royalties for ore and coal, calculated for the ton of pig-iron, in the great European producing centers, (*b*) viz: Cleveland, 81 cents; Scotland, $1 50; Cumberland, $1 56; Germany, 12 cents; France, 16 cents; Belgium, 15 to 50 cents.

TABLE 13.—*Royalties by kinds of ore and by states.*

State.	Kind of ore.	Number of tons paying royalty.	Maximum royalty.	Minimum royalty.	Average royalty.	Total royalty paid.
Alabama	Limonite	24,358	$0.22	$0.088	$0.149	$3,641 99
Do	Fossil	24,252	0.088	0.088	0.088	2,134 17
Connecticut	Limonite	23,677	1.78	1.78	1.78	42,145 06
Kentucky	do	8,605	0.176	0.176	0.175	1,514 48
Do	Carbonate	9,381	0.22	0.22	0.219	2,063 82
Maryland	Limonite	9,296	0.63	0.223	0.416	3,886 17
Do	Carbonate	2,240	0.67	0.67	0.67	1,500 80
Massachusetts	Limonite	3,845	0.33	0.22	0.267	1,027 18
Michigan	do	181,165	0.76	0.36	0.445	81,751 76
Do	Soft specular	73,893	0.54	0.33	0.446	33,006 77
Do	Specular	109,792	0.45	0.31	0.391	42,838 72
Do	Specular and magnetite	27,401	0.67	0.45	0.530	14,548 05
Missouri	Hematite	506	0.44	0.44	0.440	222 64
Do	Specular	140,091	0.89	0.13	0.463	64,921 43
New Jersey	Magnetite	350,674	0.89	0.22	0.546	191,506 05
Do	Limonite	14,271	0.49	0.22	0.433	6,185 13
New York	do	43,502	0.89	0.26	0.605	28,655 09
Do	Fossil	45,702	0.27	0.18	0.228	10,455 52
Do	Magnetite	93,251	0.89	0.13	0.347	32,414 96
Do	Hematite	8,960	0.22	0.22	0.22	1,971 20
Ohio	Carbonate	50,269	0.22	0.089	0.179	9,003 72
Pennsylvania	Limonite	646,261	1.08	0.15	0.454	293,623 41
Do	Fossil	102,001	0.49	0.089	0.264	27,024 81
Do	Carbonate	12,287	0.13	0.13	0.13	1,597 31
Do	Magnetite	210,828	0.89	0.22	0.470	99,110 42
Do	Specular	1,486	0.55	0.45	0.478	710 90
Tennessee	Limonite	7,942	0.22	0.089	0.127	1,013 64
Do	Fossil	40,721	0.26	0.20	0.234	9,554 94
Virginia	Limonite	37,520	0.22	0.09	0.216	8,123 36
Do	Magnetite	84	0.09	0.09	0.09	7 56
Do	Specular	13,440	0.29	0.22	0.237	3,192 10
West Virginia	Limonite	3,025	0.18	0.089	0.173	524 02
Do	Carbonate	13,798	0.04	0.04	0.04	551 92
Total		2,334,524				1,020,429 10

Equivalent to an average royalty of 43.7 cents per ton of 2,000 pounds, or 48.9 cents per ton of 2,240 pounds.

a Principles of the Manufacture of Iron and Steel, p. 602. *b Loc. cit.*, p. 610.

For comparison, I append some statistics since the census year, and also those for Lake Superior, Michigan, from the beginning of the development of that district:

Iron ore consumed in the United States.

Year.	Domestic, tons of 2,000 pounds.	Imported, tons of 2,000 pounds.
1882	9,744,000	*a* 660,412
1883		*b* 549,780
1884	8,556,330	*b* 545,358
1885		*c* 476,974

a J. M. Swank, in A. W. Williams' *Mineral Resources of the United States*, 1883, p. 115.
b *Annual Report American Iron and Steel Association for* 1884, p. 49.
c *Bulletin American Iron and Steel Association*, January, 1886.

The world's production of iron ore. (*d*)

Countries.	Year.	Tons of 2,000 pounds.
Great Britain	1882	18,622,240
United States	1882	10,080,000
Germany	1882	8,981,478
France	1882	3,857,000
Belgium	1882	275,500
Austria and Hungary	1881	1,157,100
Russia	1880	1,128,319
Sweden	1881	910,532
Spain	1882	5,510,000
Italy	1882	385,700
Other countries	1882	1,102,000
Total		52,009,869

d Swank, in *Mineral Resources of the United States*, p. 109.

Mr. I. Lowthian Bell (*a*) gives as below the output of the five greatest iron-ore producing countries for 1870, 1875, 1881, to which I add from J. M. Swank (*b*) some returns for 1882, 1883, 1884:

Countries.	1870.	1875.	1881.	1882.	1883.	1884.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
United Kingdom	14,370,000	15,821,000	17,446,000	18,622,240	19,469,011	18,480,000
United States	3,210,000	4,500,000	7,974,000	9,744,000		8,556,330
Germany	3,839,000	4,730,000	7,573,000	9,128,181	9,807,411	
France	2,899,000	2,540,000	3,500,000	3,920,000		
Belgium	654,000	365,000	200,000	280,000		
Spain					5,069,432	

Production of Lake Superior mines. (*a*)

Calendar year—	Tons of 2,000 pounds.
1880	2,226,109
1881	2,599,872
1882	3,301,079
1883	2,634,562
1884	2,820,212
1885	2,718,729

a Including northern Wisconsin and Minnesota.

The total output of the Lake Superior mines from their opening in 1854 to the end of 1885 was 28,445,813 tons.

a *Principles of the Manufacture of Iron and Steel*, 1884, p. 451. *b* *Annual Report American Iron and Steel Association*, 1884.

a

Production of New Jersey mines.

Calendar year—	Tons of 2,000 pounds.
1880	834, 400
1881	825, 497
1882	944, 693
1883	583, 985
1884	440, 955
1885	339, 600

b

Production of the most important districts (chiefly magnetites and hematites).

District.	1883.	1884.
	Tons.	*Tons.*
Lake Superior	2, 634, 562	2, 750, 634
Vermilion lake, Minnesota	Not opened.	69, 578
Missouri	330, 881	261, 212
Cornwall, Pennsylvania	443, 034	461, 798
Chateaugay, Lake Champlain	218, 068	240, 121
Other Lake Champlain mines	372, 466	325, 360
New Jersey	583, 985	440, 955

c

Mr. Swank's table just quoted shows the world's output of ore to have been in 1882 over 52,000,000 tons. This is roughly six and one-half times as much as the 805 mines of the United States produced in the census year. The ability of the ore deposits of the world to meet this immense demand will undoubtedly be one of the great questions of the near future. But vast as this amount of ore appears to be, it is small compared with that which will be required to meet the demands of the future if the rate of increase continues which has ruled in the past. China, Siberia, southern Asia, South America, the great islands of the world, and Africa will each go to swell the demands for construction, and multiply the already enormous requirement for maintenance.

d We have not the data for directly determining the rate of growth of the iron-ore production at home or for the world; but it is probable that if we had the data with which to construct the curve of ore production for the world, we should find that it would follow very closely the curve of pig-iron production.

On the accompanying diagram (Fig. 7*a*) Mr. Putnam has platted —

I. The production of pig-iron in the United States between 1854 and 1885.

II. The production of pig iron in Great Britain between 1856 and 1885.

III. The output of the Lake Superior mines between 1856 and 1885.

IV. The output of the New Jersey mines between 1867 and 1885.

The following table by Mr. Jeans, and here copied from Mr. Bell's *Principles of Iron and Steel Manufacture*, gives the consumption per head throughout the world:

e

Iron-producing countries.	Population.	Iron all kinds, tons consumed.	Pounds per head consumed.
United Kingdom	35, 968, 000	4, 618, 932	287. 53
United States	50, 152, 866	6, 065, 919	270. 92
France	37, 672, 048	2, 508, 706	149. 16
Germany	45, 194, 177	2, 488, 957	123. 36
Belgium	5, 519, 844	587, 000	238. 20
Russia	88, 000, 000	965, 000	24. 56
Austrian territories	37, 741, 434	625, 000	37. 09
Sweden and Norway	6, 391, 098	220, 000	77. 07
Total	306, 639, 467	18, 079, 514	132. 07
Other countries of Europe, none of which can be regarded as iron-producing.	91, 694, 283	978, 449	23. 90
Total for Europe and the United States	398, 333, 750	19, 057, 963	107. 16
British Possessions, exclusive of India	11, 465, 079	621, 483	121. 40
Total	409, 798, 829	19, 679, 446	107. 57
British Possessions in India	446, 759, 606	481, 951	2. 40
Egypt	5, 517, 000	18, 614	7. 55
South America and islands	45, 449, 357	274, 353	13. 50
Asia, exclusive of British Possessions	517, 161, 778	113, 382	. 49
Total	1, 424, 686, 570	20, 567, 746	32. 33

f

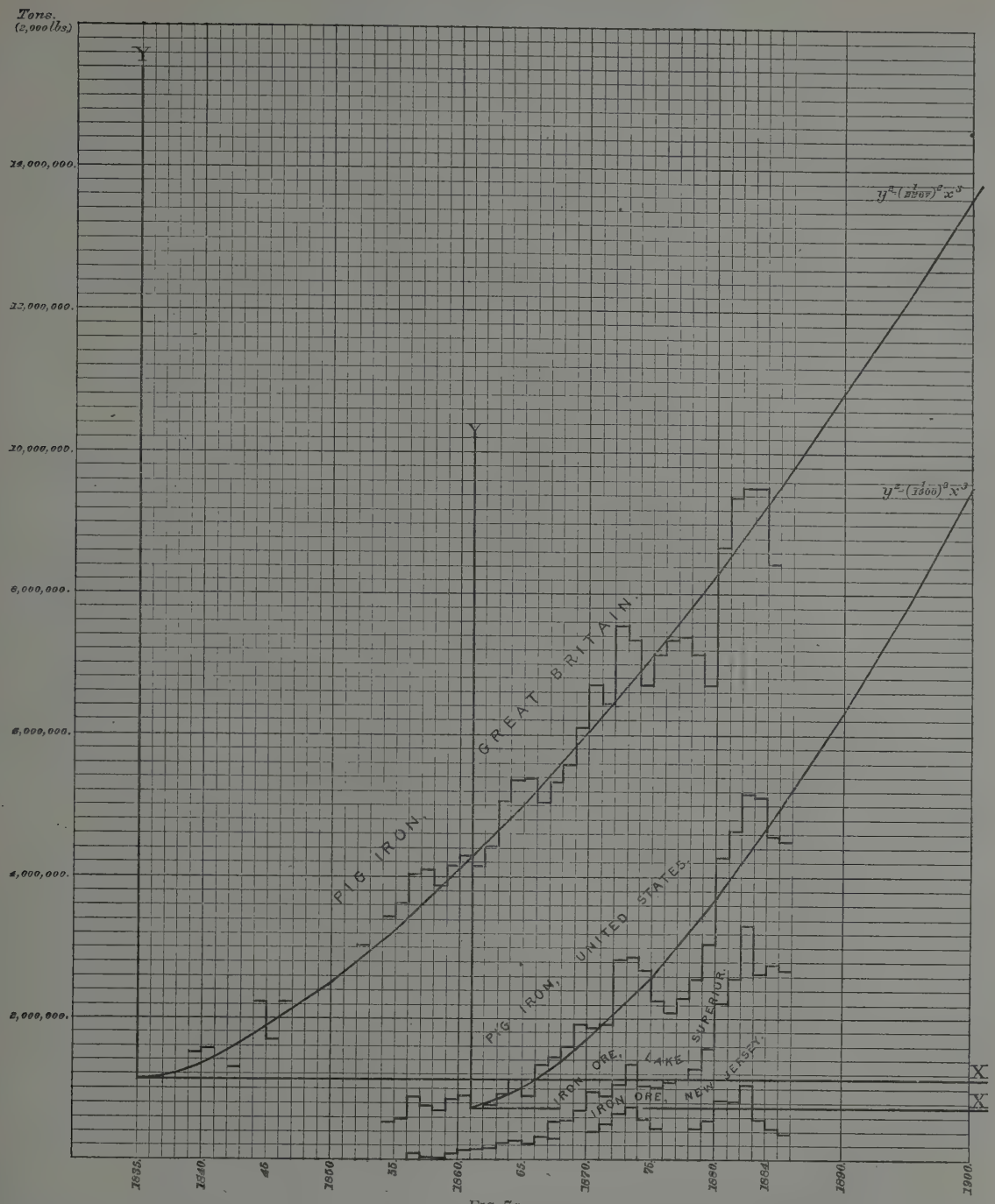


FIG. 7*a*.

The curves on the diagram which show the average increase in the production of pig-iron in Great Britain and in the United States are of such forms that, in the case of Great Britain, for instance, the area bounded by the curve, the axis of abscissas, and the ordinate at any year, indicates very closely (*a*) the total production of iron from 1835 to that year; and in the case of the United States a similarly bounded area indicates the total production of iron from 1861 to the given year. The rate of increase of production in the United States since 1861 has been a little greater than that in Great Britain since 1835. As will be seen, the two curves, although of the same general form of equation ($y^2=a^2 x^3$), have different values assigned to their constants, so that the curves are not precisely parallel. In 1866 the United States had reached the production of Great Britain in 1835, that is to say, she was then thirty-one years behind the latter country. At the end of 1884 she was but twenty-one years behind England. And at the same rate of increase for both countries, the United States will be but fifteen years behind England in 1900, and will reach and pass her in 1950, the production of pig-iron in each country for that year, as determined from the equation of their respective curves, being a little over 30,000,000 tons. [B. T. P.]

a Or, to be more precise, the area representing the production of pig-iron in Great Britain for the decade 1860–'69 differs from that bounded by the base, the ordinate at the beginning of 1860, the ordinate at the end of 1869, and the curve (*i. e.*, the actual tonnage for this period differs from the computed tonnage) by thirty-three hundredths of 1 per cent., the actual tonnage area being the larger. The area representing the production for the decade 1870–'79 differs from that bounded by the base, the ordinate at the beginning of 1870, the ordinate at the end of 1879, and the curve (*i. e.*, the actual tonnage for this period differs from the computed tonnage) by twenty-six hundredths of 1 per cent., the actual tonnage area being the smaller. The computed tonnage for the above two periods combined (*i. e.*, From 1860 to 1879, both years inclusive) is less than five thousandths of 1 per cent. larger than the actual tonnage. [B. T. P.]

In 1881 our consumption per head was, according to Mr. Jeans, 270.9 pounds, while that of Great Britain was a 287.5 pounds, and that of Europe and the United States together 107 pounds, and of the world at large about 32 pounds. Therefore, we have not yet reached the rate of consumption that obtains in Great Britain.

The increase of population, the disappearance of forests, and the constantly widening range of application of iron on both a large and a small scale, would, if continued as in the past, largely increase its use per head in the coming century. All this would imply a corresponding drain on the mines of our country, which it is doubtful that they could respond to. When we consider the comparative shallowness of the fossil-ore deposits and the lack of continuity of the limonite bodies, it seems doubtful whether they would not be exhausted within a half century, leaving the main reliance upon the high- and low-grade ores of the Archæan areas, and on the thin beds of Carboniferous ores. b

If the production of pig-iron in the United States continues to increase at the same rate that it did from 1861 to 1885, there will be produced from 1885 to 1900, as is shown by Mr. Putnam's curve, (*a*) a total of 87,250,000 tons, equal to 185,800,000 tons of ore carrying 45 per cent. of iron. This is equivalent to a bed 1 yard thick and covering an area of $17\frac{9}{10}$ square miles.

The total predicted between 1885 and 1950—nearly 1,060,000,000 tons—is equivalent to 3,180,000,000 tons of ore carrying $33\frac{1}{3}$ per cent. of iron This amount would cover to a depth of 1 yard an area of $342\frac{2}{10}$ square miles; or it would form a deposit 3 feet thick extending 900 feet in depth and $2{,}007\frac{6}{10}$ miles in length.

The more immediate result will be, as before stated, the rapid exhaustion of the known deposits of rich ores and the more extensive mining of those of lower grades.

To bring Asia and South America up to the same consumption per head as Russia, or say 25 pounds, would c require an increase in the world's product of about 30,000,000 tons of 40 per cent. ore.

But if no unforeseen cause should intervene, the coming century will see the habitable lands of the whole globe divided among and occupied by rapidly-increasing populations of European and of Chinese descent. Should there be nothing substituted for iron, it is difficult to see how they could do with a smaller consumption per head than that of Europe and the United States, or say 100 pounds, and it would require probably more than 100,000,000 tons of ore annually to supply the demand before the end of this century.

If we may assume that the curve of the world's production from 1885 to 1950 will approximate in shape that of Great Britain, and that this will continue to be of the same form as it was from 1835 to 1885, (*b*) then taking the world's output of ore in 1882 at 52,000,000 tons, or $2\frac{8}{10}$ times that of Great Britain, there would be required for the period from 1885 to 1900 a total of over 1,454,000,000 tons. This would cover 1 yard deep an area of $156\frac{3}{10}$ square d miles; or occupy a deposit 1 yard thick, 900 feet deep, and $917\frac{3}{10}$ miles long.

For the period from 1885 to 1950 there would be required, under like assumptions, the enormous amount of nearly 10,635,000,000 tons, equal to a bed 1 yard thick covering $1{,}144\frac{4}{10}$ square miles; or to a deposit 1 yard thick, 900 feet deep, and 6,714 miles long.

There can be little doubt that the invention of new kinds of steel will tend to largely increase the efficiency and durability of the metal, and so diminish the amount used up in maintenance.

There can also be little doubt that aluminum will become an available metal, and that this and other light materials will be used for many purposes for which only iron and steel are now employed. But it may well be doubted whether this saving will not be compensated by a more extended application of iron in other directions.

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a The ordinates for every fifth year were computed by the formula: $Y^2=(\frac{1}{1800})^2X^3$; in which $Y=1=2{,}000{,}000$ net tons, and $X=0.9=$ten years. To the value of Y (expressed in tons) was added in every case 731,544 tons, being the production of pig-iron in 1861. The area of each five-year period was then computed on the assumption that the curve between consecutive five-year ordinates does not differ sensibly from a straight line.

b $Y^2=(\frac{1}{2267})^2X^3$. The total production for Great Britain and the world was computed by means of this formula in a manner similar to that above described for computing the total production of the United States.

THE CENTER OF TOTAL PRODUCTION OF IRON ORE IN THE UNITED STATES IN THE CENSUS YEAR.

By Bayard T. Putnam.

The center of total production of iron ore in the United States, using the expression as defined for the center of population, in the *Statistical Atlas of the United States* (1874), and in the volume on the *Population of the United States* (1880), is the point at which equilibrium would be reached were the country taken as a plain surface, itself without weight, but capable of sustaining weight, and loaded with the iron ore produced during the period under consideration at the points where it was mined, each ton exerting pressure on the pivotal point directly proportioned to its distance therefrom.

The center of production of iron ore in the United States in the census year is found to be at latitude 41° 48½′ north, longitude 80° 14⅓′ west from Greenwich. This point is in Cussewago township, Crawford county, Pennsylvania, about 12 miles north, 23½° west from Meadville, and midway between Potter's Corner post-office and Crossingville post-office.

In determining this center the production of iron ore in each county was assumed to be concentrated at the geographical center of the county, excepting in cases where such an assumption was manifestly erroneous. (*a*) The geographical center of a county was considered as being coincident with the center of gravity of a plane of uniform weight, of the exact shape of the county. It was obtained practically by cutting out carefully the county from a map (scale 50 miles to the inch), and ascertaining the center of gravity of the piece by supending it successively at three points and finding the intersection of the vertical lines through the points of suspension. The geographical centers of the counties thus obtained were platted on a map. These several centers of ore-production were then grouped graphically, in accordance with the mechanical principle that the sum of two forces, acting at a point between them, and distant from either inversely as the force, exerts the same pressure on the pivotal point as the two forces acting separately. The resultant of the two counties was combined with a third county, and so on, until the resultant of the whole state, or in other words, the center of production of the state, was obtained. The latitudes and longitudes of the several state centers were then determined by measurement, and the moment of each state, with reference to an assumed meridian and parallel as axes calculated in the ordinary manner, *i. e.*, by multiplying its output in tons by the difference in latitude (expressed in minutes) between its center and the assumed parallel for the north or south moment; and by the difference in longitude (measured on the nearest half-degree-parallel and expressed in yards) between its center and the assumed meridian for the east or west moments. The difference between the sums of the east and west moments divided by the total product of ore in the United States gave a correction for the position of the assumed meridian, that is for the longitude of the center; and a correction for the latitude of the center was similarly determined.

The method of combining the counties as above explained will give necessarily a result for the position of the center differing somewhat from that obtained by calculating the moment of each county, as in the latter case the distance from the pivotal point, *i. e.*, the length of the lever by which the force exerts the pressure, is measured on the parallel and meridian, while it is not so measured in the graphic method. But the difference is very slight, especially within the area of any one state. The position of the center of the total production of the whole United States, as obtained by the use of the graphic method throughout, was latitude 41° 52′ north, longitude 80° 10′ west, which differs from that obtained by calculation of the movements of the several state centers by less than 4′ in latitude and about the same amount in longitude. It is scarcely necessary to say that of the two methods the graphic is very much less laborious.

a For instance, only one mine in each of the states of Maine and Oregon produced ore in the census year; the center of production of these states was therefore taken as at these mines. Again, all the mines in Saint Lawrence county, New York, are in the southern part of the county, near Gouverneur, and that town was consequently taken as the center of production of the county, etc.

a The "center", as above defined, is the one used in all the census reports thus far published. It is not the only point, however, which might be taken as satisfying the expression, *the center of total production*, and it moreover has a disadvantage in giving undue importance to a ton of product, simply because the latter is at a relatively great distance from the center. The 7,000 tons of ore mined in Oregon have as much influence in determining the longitude of the center of total production as 70,000 tons mined in Preston county, West Virginia.

Another "center" of total production might, for the purpose of indicating the average movement of the industry during a given period, be defined as being at the intersection of a meridian and parallel, the former dividing the east and west production equally, the latter dividing the north and south production equally. Such a center of the production of iron ore in the census year is in about latitude 40° 51′ north, longitude 77° 40′ west. This point is in the east central part of Centre county, Pennsylvania.

Both of the above points are indicated on the map of the United States, Plate XIV.

STATISTICS

OF THE

PRODUCTION OF IRON ORE IN THE CENSUS YEAR.

TABLE 14.—*Statistics of the production of iron ore, by states and counties.*

[GENERAL REMARKS.—With the exceptions of columns 5 and 6, in which the regular and irregular product are combined, all the questions in columns 1 to 40, both full year's production at the rate of the monthly production during the census year. *Capital in real estate* refers to mineral right only. *Working capital*, when the original figures have been replaced by estimates. *Furnaces:* Great care has been taken to avoid duplication of the products of regular mines in entering ores to their true sources as far as possible. Further explanations will be found under each state. The full title of Mr. Swank's report, referred to in the

ALABAMA.

	Counties.	Number of establishments.	Maximum capacity of yearly production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, *i. e.*, product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
	The State	17	310,109	184,110	$189,108	191,676	$201,865	109	6	590	33	738
1	Bibb	1	28,350	5,670	6,250	5,670	6,250			24	2	26
2	Calhoun	2	25,574	24,474	26,812	27,842	32,129			52	6	58
3	Cherokee	4	49,948	32,996	32,500	32,996	32,500			122	1	123
4	De Kalb	1	2,721	227	250	227	250			10		10
5	Etowah	2	21,340	21,004	22,152	21,004	22,152	20	1	24	1	46
6	Jefferson	3	72,260	45,975	49,461	45,975	49,461	71	3	155		229
7	Shelby	1	26,000	25,787	25,787	25,787	25,787			40	15	55
8	Saint Clair	1	34,020	12,685	16,779	12,685	16,779	18	2	80	8	108
9	Talladega	1	18,608	1,140	1,005	5,338	8,445			50		50
10	Tuscaloosa	1	36,288	14,152	8,112	14,152	8,112			33		33

CONNECTICUT.

	The State	4	45,800	35,018	$147,799	35,018	$147,779	20		179	1	200
1	Litchfield	4	45,800	35,018	147,799	35,018	147,799	20		179	1	200

DELAWARE.

	The State	2	18,389	2,726	$6,553	2,726	$6,553			36	11	47
1	New Castle	2	18,389	2,726	6,553	2,726	6,553			36	11	47

GEORGIA.

	The State	7	101,157	72,705	$120,692	91,416	$143,622	50		287	5	342
1	Bartow	4	29,520	10,623	24,562	11,353	27,762			87	5	92
2	Dade	1	44,225	44,225	77,393	47,206	82,129	50		150		200
3	Polk	2	27,412	17,857	18,737	32,857	33,737			50		50

KENTUCKY.

	The State	5	105,420	33,522	$88,930	64,809	$165,905	45		255	25	325
1	Bath					550	1,375					
2	Boyd					3,271	8,556					
3	Carter	1	5,670	2,495	6,600	14,749	39,258			25		25
4	Estill					1,500	3,000					
5	Greenup	2	26,000	13,917	42,955	14,058	43,479			162	25	187
6	Lyon	1	56,700	8,505	16,875	8,505	16,875	20		42		62
7	Powell					1,500	3,000					
8	Trigg	1	17,050	8,605	22,500	8,605	22,500	25		26		51
9	Boyd and Greenup					11,435	25,670					
10	Name of county not given					636	2,192					

INDIANA.

	The State					513	$1,018					
1	Martin					513	1,018					

TABLE 14.—*Statistics of the production of iron ore, by states and counties.*

inclusive, relate to regular establishments only. *Tons* are of 2,000 pounds throughout. *Maximum capacity*, when not returned, has been estimated as equal to one not returned, has been estimated as equal to one month's wages and materials. *Employés:* Wherever the maximum instead of the average number was returned, the amounts mined or bought by furnaces. In computing these amounts all the blast-furnace returns from the neighboring states were consulted, so as to trace the remarks, is *Statistics of the Iron and Steel Production of the United States, compiled by James M. Swank, special agent of the Census.*]

ALABAMA.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
503	216	19	$123,342	$438,772	$46,770	$50,900	$536,442	9	$17,625	a 73	b $2,835	107	$11,070	
24	2	.....	2,638	3,500	2,830	6,000	12,330	1	800	.....	.....	6	630	1
56	.....	2	14,140	30,500	2,600	1,200	34,300	1	1,100	.....	.....	5	750	2
110	13	.....	27,270	77,000	5,800	4,800	87,600	2	4,000	60	1,400	10	1,000	3
10	.....	.....	300	1,500	100	500	2,100	.....	200	.....	.....	.....	.....	4
12	30	4	13,247	3,000	3,000	1,400	7,400	1	2,100	4	320	14	1,400	5
211	16	2	25,002	103,000	12,500	7,500	123,000	1	3,520	.....	.....	3	240	6
30	24	1	15,000	99,772	7,165	15,000	121,937	1	1,505	2	250	12	1,300	7
20	82	6	18,480	15,500	6,000	8,000	29,500	1	2,200	2	200	35	3,500	8
.....	49	1	1,005	100,000	2,675	500	103,175	.....	200	4	600	20	2,000	9
30	.....	3	6,260	5,000	4,100	6,000	15,100	1	2,000	1	65	2	250	10

a Includes 64 oxen. b Includes value of 64 oxen.

CONNECTICUT.

100	90	10	$61,167	$368,000	$39,800	$18,500	$426,300	.....	$20,853	98	$11,950	.....	.....	
100	90	10	61,167	368,000	39,800	18,500	426,300	.....	20,853	98	11,950	.....	.....	1

DELAWARE.

20	25	2	$2,865	$40,000	$6,300	$2,000	$48,300	.....	$941	6	$400	16	$1,140	
20	25	2	2,865	40,000	6,300	2,000	48,300	.....	941	6	400	16	1,140	1

GEORGIA.

217	105	20	$108,796	$101,200	$33,935	$35,790	$170,925	4	$8,345	.....	.....	68	$8,650	
46	40	6	10,796	16,800	6,285	2,790	25,875	1	2,025	.....	.....	38	4,750	1
125	65	10	90,000	75,000	25,000	30,000	130,000	1	5,210	.....	.....	22	2,500	2
46	.....	4	8,000	9,400	2,650	3,000	15,050	2	1,110	.....	.....	8	1,400	3

KENTUCKY.

224	88	13	$69,319	$678,329	$59,500	$42,000	$779,829	2	$8,100	91	$8,300	26	$1,500	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	E
20	3	2	5,500	101,000	40,000	7,000	148,000	1	100	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
124	55	8	36,819	427,329	4,500	15,000	446,829	.....	.....	26	1,300	26	1,500	5
40	20	2	12,000	50,000	5,000	10,000	65,000	.....	3,000	40	4,500	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
40	10	1	15,000	100,000	10,000	10,000	120,000	1	5,000	25	2,500	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10

INDIANA.

.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

ALABAMA.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
	The State	6	$4,550	192	6	$2,250	192	1,536	$2,680	31,000	$310			$4,240
1	Bibb													600
2	Calhoun	2	450	20	2	300	20	450	640					
3	Cherokee	2	1,000	22	2	450	22	101	300					1,057
4	De Kalb													185
5	Etowah									15,000	150			552
6	Jefferson							310	930					1,350
7	Shelby	1	1,100	50	1	500	50	365	547	1,000	10			
8	Saint Clair									15,000	150			216
9	Talladega													
10	Tuscaloosa	1	2,000	100	1	1,000	100	310	263					280

CONNECTICUT.

	The State	5	$2,800	105	6	$5,200	135	5	$25	2,100	$105	20,000	$325	$3,669
1	Litchfield	5	2,800	105	6	5,200	135	5	25	2,100	105	20,000	325	3,669

DELAWARE.

	The State	4	$2,500	40	3	$1,300	28	23	$53					$3
1	New Castle	4	2,500	40	3	1,300	28	23	53					3

GEORGIA.

	The State				1	$300	20							$4,200
1	Bartow													625
2	Dade				1	300	20							3,000
3	Polk													575

KENTUCKY.

	The State									10,000	$500			$1,470
1	Bath													
2	Boyd													
3	Carter													
4	Estill													
5	Greenup													
6	Lyon													720
7	Powell													
8	Trigg									10,000	500			750
9	Boyd and Greenup													
10	Name of county not given													

INDIANA.

	The State													
1	Martin													

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
ALABAMA.									
$17,765	$6,050	.....	.....	.....	.....	7,566	$12,757	*Capital in real estate*, when not returned, has been estimated equal to the royalty on six full years' production at the rate of the monthly production during the census year.	
.....	1,200	.....	.....	.....	.....	.....	.....	*Wages* are probably "net," as most of the mines are open-cut and wages are generally low.	1
750	1,000	.....	.....	.....	.....	3,368	5,317	*Materials* include powder, lumber, fuel, and feed for oxen, horses, and mules.	2
2,950	.....	.....	.....	.....	.....	.....	.....	Feed for oxen has been estimated at $4 per month, feed for horses at $6 per month, and feed for mules at $6 per month. To total materials may be added $1,362 for half-feed of horses and mules during idle time of mines temporarily suspending operations during the census year.	3
.....	.....	.....	.....	.....	.....	.....	.....		4
.....	.....	.....	.....	.....	.....	.....	.....	*Furnaces:* The following data, referring to mines operated in connection with furnaces, are probably duplicated by Mr. Swank's returns: Number of mines, 5. Product, 76,534 tons; value, $72,678. Employés, 216; wages, $39,335. Real estate, $257,000; plant, $17,475; working capital, $5,800; total capital, $280,275.	5
5,000	3,000	.....	.....	.....	.....	.....	.....		6
5,565	400	.....	.....	.....	.....	.....	.....		7
.....	450	.....	.....	.....	.....	.....	.....		8
.....	.....	.....	.....	.....	.....	4,198	7,440		9
3,500	.....	.....	.....	.....	.....	.....	.....		10
CONNECTICUT.									
$22,225	.....	.....	.....	.....	.....	.....	.....		
22,225	.....	.....	.....	.....	.....	.....	.....		1
DELAWARE.									
$4,400	$150	.....	.....	.....	.....	.....	.....		
4,400	150	.....	.....	.....	.....	.....	.....		1
GEORGIA.									
$1,250	$16,800	.....	.....	.....	.....	18,711	$22,930	*Capital in real estate*, when not returned, has been estimated as equal to the royalty on six full years' production at the rate of the monthly production in the census year.	
.....	.....	.....	.....	.....	.....	730	3,200	*Materials* include powder, fuel, lumber, and feed, the latter estimated at $5 per head per working month. To the total materials for the state may be added $615 for half-feed for horses and mules during idle time of mines temporarily suspending operations during the census year.	1
1,000	15,000	.....	.....	.....	.....	2,981	4,730		2
250	1,800	.....	.....	.....	.....	15,000	15,000		3
								Furnaces: The following returns of mines operated in connection with furnaces are probably duplicated by Mr. Swank's returns: Number of mines, 3. Product, 21,441 tons; value, $29,937. Employés, 104; wages, $10,160. Real estate, $11,400; plant, $5,150; working capital, $5,000; total capital, $21,550.	
KENTUCKY.									
.....	.....	4,940	$10,155	.....	$6,000	26,347	$66,820	*Wages* represent net wages.	
.....	.....	550	1,375	.....	.....	.....	.....	*Materials* include powder, lumber, fuel, etc., and feed, estimated at $6 per head per month. Feed has been added to the original returns. To total materials may be added $1,992 for half-feed of horses and mules during idle time of mines temporarily suspending operations during census year.	1
.....	.....	1,390	2,780	.....	.....	1,881	5,776	*Capital in real estate*, when not returned, has been estimated as equal to the royalty on six full years' production at the rate of the monthly production in the census year.	2
.....	.....	.....	.....	.....	.....	12,254	32,658		3
.....	.....	1,500	3,000	.....	3,000	.....	.....	*Furnaces:* Among the returns from mines, the following from those operated by and in connection with furnaces are probably duplicated by Mr. Swank's report: Number of mines, 6. Product, 69,961 tons; value, $85,349. Employés, 307; wages, $61,296. Real estate, $541,000; plant, $80,959; working capital, $57,400; total capital, $679,359.	4
.....	.....	.....	.....	.....	.....	141	524		5
.....	.....	.....	.....	.....	.....	.....	.....		6
.....	.....	1,500	3,000	.....	3,000	.....	.....	*Number of mines:* The 8,505 tons reported from one mine in Lyon county came from forty openings, each of which might be, inappropriately, called a mine.	7
.....	.....	.....	.....	.....	.....	.....	.....		8
.....	.....	.....	.....	.....	.....	11,435	25,670		9
.....	.....	.....	.....	.....	.....	636	2,192		10
INDIANA.									
.....	.....	.....	.....	.....	.....	513	$1,018		
.....	.....	.....	.....	.....	.....	513	1,018		1

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MAINE.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
	The State	1	12,000	6,000	$9,000	6,000	$9,000	.....	.....	20	.....	20
1	Piscataquis	1	12,000	6,000	9,000	6,000	9,000	.....	.....	20	.....	20

MARYLAND.

	The State	13	145,296	57,940	$118,050	139,628	$421,691	12	.....	295	22	329
1	Anne Arundel	1	10,000	2,472	8,000	6,184	22,487	.....	.....	25	5	30
2	Alleghany	1	50,400	3,253	7,260	4,512	11,788	8	.....	1	.....	9
3	Baltimore	7	33,376	25,536	51,032	63,842	196,647	4	.....	127	15	146
4	Carroll	3	20,160	8,836	11,929	17,352	45,584	.....	.....	52	.....	52
5	Cecil	.....	.....	.....	.....	2,016	8,064	.....	.....	.....	.....	.....
6	Frederick	1	31,360	17,843	39,829	18,166	40,506	.....	.....	90	2	92
7	Harford	.....	.....	.....	.....	277	845	.....	.....	.....	.....	.....
8	Howard	.....	.....	.....	.....	14,675	53,737	.....	.....	.....	.....	.....
9	Montgomery	.....	.....	.....	.....	25	100	.....	.....	.....	.....	.....
10	Prince George	.....	.....	.....	.....	12,019	41,433	.....	.....	.....	.....	.....
11	Washington	.....	.....	.....	.....	560	500	.....	.....	.....	.....	.....

MASSACHUSETTS.

	The State	9	87,360	62,637	$226,130	62,637	$226,130	224	.....	134	24	382
1	Berkshire	9	87,360	62,637	226,130	62,637	226,130	224	.....	134	24	382

MICHIGAN.

	The State	43	2,223,365	1,837,712	$6,034,648	1,837,712	$6,034,648	3,120	17	2,229	196	5,562
1	Marquette	31	1,589,959	1,346,365	4,675,430	1,346,365	4,675,430	2,394	16	1,480	126	4,016
2	Menominee	12	633,406	491,347	1,359,218	491,347	1,359,218	726	1	749	70	1,546

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MAINE.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
12	8	.....	$9,000	$2,500	$2,000	$2,000	$6,500	.....	$3,150	16	$1,600	.....	.....	
12	8	.....	9,000	2,500	2,000	2,000	6,500	.....	3,150	16	1,600	.....	.....	1

MARYLAND.

119	192	18	$61,138	$310,600	$135,464	$44,450	$490,514	2	$23,726	37	$5,600	45	$6,100	
.....	29	1	3,000	1,100	500	1,200	2,800	.....	600	.....	.....	.....	.....	1
4	4	1	974	50,000	20,000	5,000	75,000	.....	300	3	450	2	250	2
12	124	10	40,000	142,500	29,964	12,750	185,214	1	16,652	30	4,650	29	3,750	3
28	21	3	8,188	17,000	5,000	5,500	27,500	.....	2,174	4	500	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
75	14	3	8,976	100,000	80,000	20,000	200,000	1	4,000	.....	.....	14	2,100	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11

MASSACHUSETTS.

216	156	10	$117,158	$183,000	$70,600	$22,400	$276,000	.....	$43,136	50	$6,575	2	$200	
216	156	10	117,158	183,000	70,600	22,400	276,000	.....	43,136	50	6,575	2	200	1

MICHIGAN.

3,163	2,189	210	$2,573,857	$12,452,311	$2,789,944	$2,254,520	$17,496,775	14	$939,711	390	$64,350	37	$4,670	
2,422	1,476	118	2,040,259	6,891,311	2,091,159	1,874,600	10,857,070	6	623,312	270	50,375	22	3,350	1
741	713	92	533,598	5,561,000	698,785	379,920	6,639,705	8	316,399	120	13,975	15	1,320	2

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MAINE.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
	The State													$2,000
1	Piscataquis													2,000

MARYLAND.

	The State	11	$9,600	263	11	$7,200	263	910	$2,000					$789
1	Anne Arundel													
2	Alleghany													38
3	Baltimore	8	5,400	173	8	5,400	173							1
4	Carroll	1	700	30	1	800	30							30
5	Cecil													
6	Frederick	2	3,500	60	2	1,000	60	910	2,000					720
7	Harford													
8	Howard													
9	Montgomery													
10	Prince George													
11	Washington													

MASSACHUSETTS.

	The State	8	$9,600	220	19	$13,450	455			33,628	$2,354	25,000	$350	$6,818
1	Berkshire	8	9,600	220	19	13,450	455			33,628	2,354	25,000	350	6,818

MICHIGAN.

	The State	134	$210,850	6,574	125	$108,852	6,209	52,045	$116,969	3,571,000	$25,381	6,833,000	$94,569	$160,561
1	Marquette	112	181,450	5,891	97	84,882	5,069	34,675	83,112	1,231,000	13,381	4,048,000	60,689	144,190
2	Menominee	22	29,400	683	28	23,970	1,140	17,370	33,857	2,340,000	12,000	2,785,000	33,880	16,371

TABLE 14.—*Production of iron ore, by states and counties*—Continued.

MAINE.

Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
								The original return for materials was $2,000, to which $1,500 has been added for 1880.	1

MARYLAND.

$17,164	$9,900	3,581	$12,244	$3,600	$4,094	78,107	$291,397		
						3,712	14,487	*Product of mines operated by furnaces:* Among the "mine schedules" proper there are 9 mines operated by and in connection with furnaces. The aggregate production of such mines was 33,593 tons, valued at $61,509; total number of employés, 179; total wages, $44,522; capital, in real estate, $197,500; in plant, $49,964; in working capital, $18,250; total capital, $265,714. These amounts are probably duplicated by Mr. Swank's returns.	1
	150	1,005	3,680	500	1,794	254	848		2
13,064	5,450					38,306	145,615		3
1,700	1,800					8,516	33,655		4
		2,016	8,064	3,100	1,800			*Wages* represent the net earnings of employés.	5
2,400	2,500					323	677	*Materials* include coal, lumber, powder, fuse, oil, iron, tools, and feed. The latter reckoned at $9 per month per head (mule or horse), during the time the mine was in operation. To this may be added, for half-feed of mules and horses during idle time by mines temporarily suspending work during the census year, $1,676, making the total value of materials $25,402.	6
						277	845		7
						14,675	53,737		8
						25	100		9
						12,019	41,433		10
		560	500		500				11

MASSACHUSETTS.

$34,900									
34,900									1

MICHIGAN.

$838,558								*Maximum capacity*, when not given, has been estimated equal to 8 months' production (in the case of open-cut mines), at the monthly rate of production during the census year, but in the case of mines which work wholly or partly underground, to 12 months' production.	
770,558									1
68,000								*Value at mine*, when not given, has been estimated at the price on ship-board for 1879, as given by the Marquette *Mining Journal*, less $1 50 per ton for railroad freight and loading ship. The values returned by the operators are, almost without exception, those ruling in 1879. As the ore mined during the spring of 1880, although not sold in the census year, was worth the prices brought by ores in 1880, which were about 50 per cent. higher than those of 1879, about 50 per cent. should be added to the value of one-half of the census year's production, *i. e.*, $1,508,062, making the aggregate value of the production for census year $7,543,310.	2
								Capital in real estate, when not returned, has been estimated as equal to the royalty (when not given estimated at 50 cents per ton) on the production of 7½ full years at the rate of the monthly production during the census year. This is on the supposition that the mines will generally last not less than 10 years, the difference between 7½ and 10 being allowed for gain of interest. These estimates will seem low in proportion to the profits of the mines, but those profits do not represent those of the owners of mineral land but of the operators of the mines, and include interest on the capital invested in plant and on working capital, and the profits derived from the business of conducting the mines.	
								Wages have been taken to represent the net earnings of miners, etc., as they are not high for the region.	
								Materials include explosives, lumber, fuse, oil for lighting and lubricating, iron for all purposes, tools, etc., together with feed for horses and mules. It has been assumed that the latter was, as a rule, included in the original returns. Whenever the returns were not sufficiently large to include feed, $12 per working month per head has been added. To the total materials for the state should be added, for half-feed of horses and mules during idle time in the case of mines temporarily suspending operations during the census year, $2,783.	
								Lumber, unsawed, when used and not returned, has been estimated at ½ linear foot per ton of ore mined and valued at $\frac{7}{10}$ cent per linear foot, the price returned in many cases. To total amount of unsawed lumber add 25 stull pieces, returned in a "note", but included in value.	
								Cord-wood, when not valued, has been estimated at $2 per cord.	
								Lumber, sawed, when not valued, has been estimated at $12 per 1,000 feet, B M.	
								Explosives, when used and not given, have been estimated at 5, 8, and 13 cents per ton of ore mined, according to the purpose for which explosives were used and the kind of ore.	

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MISSOURI.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
	The State	48	968,001	386,197	$1,674,875	386,197	$1,674,875	358	10	1,435	90	1,893
1	Crawford	14	169,487	87,033	210,368	87,033	210,368	47	.....	398	1	446
2	Dent	15	167,604	58,878	160,071	58,878	160,071	8	.....	376	20	404
3	Franklin	3	32,499	8,064	24,725	8,064	24,725	10	.....	56	.....	66
4	Gasconade	1	.....	1,120	2,750	1,120	2,750	.....	.....	20	.....	20
5	Iron	3	188,660	57,297	138,093	57,297	138,093	290	10	114	20	434
6	Phelps	9	66,326	29,326	76,435	29,326	76,435	.....	.....	190	4	194
7	Saint Francois	2	341,185	144,265	1,062,051	144,265	1,062,051	3	.....	255	45	303
8	Washington	1	2,240	214	382	214	382	.....	.....	26	.....	26

NEW JERSEY.

	The State	109	1,487,829	754,872	$2,900,442	757,372	$2,910,442	3,264	69	1,385	93	4,811
1	Bergen	1	3,500	280	1,250	280	1,250	.....	.....	6	.....	6
2	Hunterdon	18	74,642	19,627	82,515	19,627	82,515	141	1	98	8	248
3	Morris	55	1,034,813	568,420	2,353,819	568,420	2,353,819	2,451	52	830	57	3,390
4	Passaic	6	60,550	29,166	58,660	29,166	58,660	74	1	51	13	139
5	Sussex	15	225,250	87,165	244,776	89,665	254,776	349	6	226	6	587
6	Warren	14	89,074	50,214	159,422	50,214	159,422	249	9	174	9	441

NEW YORK.

	The State	78	2,149,129	1,239,759	$3,499,132	1,262,127	$3,654,872	2,417	35	2,083	140	4,675
1	Clinton	6	296,692	92,166	354,584	92,166	354,584	510	.....	293	10	813
2	Columbia	3	40,340	18,224	73,219	18,224	73,219	.....	.....	87	3	90
3	Dutchess	11	147,886	125,859	396,672	125,859	396,672	.....	.....	466	38	504
4	Essex	13	770,121	630,944	1,809,293	631,807	1,811,718	1,131	3	297	.....	1,431
5	Jefferson	4	131,000	64,111	151,981	64,111	151,981	86	.....	203	.....	289
6	Oneida	6	90,720	37,052	63,899	37,052	63,899	60	.....	155	15	230
7	Orange	16	138,620	88,988	254,434	89,562	256,030	277	14	131	5	427
8	Putnam	8	292,070	76,446	170,050	76,446	170,050	217	18	226	5	466
9	Richmond	3	37,840	8,288	14,530	9,318	18,633	.....	.....	41	.....	41
10	Saint Lawrence	2	61,600	30,309	81,400	30,654	82,015	61	.....	25	.....	86
11	Washington	2	44,800	18,892	47,700	18,892	47,700	75	.....	15	2	92
12	Wayne	4	97,440	48,390	81,370	48,390	81,370	.....	.....	144	62	206
13	Name of county not given	.....	.....	.....	.....	*a* 19,646	147,001	.....	.....	.....	.....	.....

a In table 8 this amount has been apportioned as follows: To Dutchess county, 795 tons; to Orange county, 1,180 tons; to Putnam county, 17,671 tons.

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MISSOURI.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1,126	690	77	$417,371	$4,666,223	$678,313	$254,020	$5,598,556	7	$104,955	67	$5,015	241	$31,370	
330	103	13	74,087	123,400	17,325	37,270	177,995	3	11,041	7	480	17	1,650	1
311	71	22	85,664	158,700	287,140	41,600	487,440	3	11,232	14	760	15	1,130	2
47	15	4	8,601	69,000	2,600	5,200	76,800	.....	1,800	12	600	2	175	3
19	.....	1	750	.....	.....	25	25	.....	117	.....	.....	.....	.....	4
169	253	12	89,647	967,954	54,328	50,900	1,073,182	.....	24,883	6	660	19	2,750	5
143	38	13	26,913	25,300	7,330	17,500	50,130	.....	4,189	17	1,040	12	1,090	6
102	190	11	130,685	3,317,869	309,570	100,025	3,727,464	1	51,673	11	1,475	176	24,575	7
5	20	1	1,024	4,000	20	1,500	5,520	.....	20	.....	.....	.....	.....	8

NEW JERSEY.

2,931	1,754	126	$1,606,257	$4,797,620	$841,226	$562,915	$6,201,761	23	$584,229	70	$6,665	48	$5,500	
4	1	1	200	8,000	.....	250	8,250	.....	50	.....	.....	.....	.....	1
159	75	14	38,426	101,150	44,225	18,115	163,490	.....	12,515	11	1,140	8	1,000	2
2,097	1,225	68	1,298,615	2,962,720	654,674	407,725	4,025,119	18	497,599	35	3,150	18	2,100	3
62	72	5	39,642	264,000	14,123	27,800	305,923	1	11,464	9	950	2	300	4
394	174	19	135,703	1,131,200	62,650	74,950	1,268,800	2	33,519	12	1,225	.....	.....	5
215	207	19	93,671	330,550	65,554	34,075	430,179	2	29,082	3	200	20	2,100	6

NEW YORK.

2,269	2,216	190	$1,507,395	$6,443,449	$1,281,740	$537,950	$8,263,139	24	$534,395	323	$39,035	48	$6,880	
431	339	43	209,228	390,000	156,500	102,000	648,500	5	44,992	50	4,650	1	50	1
51	30	9	22,532	152,500	68,300	8,000	228,800	3	21,248	41	6,500	.....	.....	2
227	253	24	164,056	913,549	150,800	54,500	1,118,849	1	59,402	112	12,985	15	1,000	3
607	788	36	519,988	2,919,525	542,120	206,100	3,667,745	4	268,084	41	6,625	4	230	4
226	49	14	111,789	222,000	63,000	27,000	312,000	3	19,252	13	1,300	.....	.....	5
40	179	11	43,774	42,000	15,250	8,150	65,400	.....	8,892	13	850	.....	.....	6
218	196	13	137,219	808,500	141,700	60,500	1,010,700	6	44,144	14	1,350	14	2,800	7
232	219	15	168,260	568,530	54,550	28,500	651,580	.....	47,659	6	825	.....	.....	8
22	16	3	7,500	37,000	6,020	3,700	46,720	.....	1,670	8	1,100	14	2,800	9
55	23	8	44,700	110,000	60,000	12,500	182,500	.....	10,750	3	250	.....	.....	10
60	27	5	26,000	190,000	11,500	14,000	215,500	2	3,672	2	200	.....	.....	11
100	97	9	52,349	89,845	12,000	13,000	114,845	.....	4,630	20	2,400	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MISSOURI.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
	The State	17	$31,800	448	24	$20,150	594	6,447	$15,157	155,000	$2,300			$28,972
1	Crawford	4	1,900	61	4	1,800	79	472	707	5,000	50			7,342
2	Dent	3	1,900	47	3	1,550	65	575	1,150					7,043
3	Franklin													472
4	Gasconade													112
5	Iron	1	8,000	80	5	4,800	125	400	800					7,258
6	Phelps									150,000	2,250			2,701
7	Saint Francois	9	20,000	260	12	12,000	325	5,000	12,500					4,044
8	Washington													

NEW JERSEY.

	The State	152	$195,945	4,486	192	$110,005	4,921	2	$8	1,067,751	$43,976			$105,130
1	Bergen													37
2	Hunterdon	9	10,145	204	11	6,050	210			6,000	300			1,980
3	Morris	113	155,600	3,619	143	84,965	3,821			904,781	37,015			82,288
4	Passaic	4	4,500	154	5	2,500	160			12,000	510			206
5	Sussex	13	10,900	266	17	8,190	355	2	8	55,970	2,691			15,834
6	Warren	13	14,800	243	16	8,300	375			89,000	3,460			4,785

NEW YORK.

	The State	87	$121,591	3,039	118	$115,034	4,267	20,698	$37,121	49,450	$1,320			$77,093
1	Clinton	11	14,850	360	15	11,550	405	13,700	21,250	3,000	225			13,200
2	Columbia	5	6,275	100	7	8,500	260	50	100					700
3	Dutchess	11	15,450	365	25	22,800	561	8	16	1,250	25			7,779
4	Essex	25	41,300	1,340	30	36,700	1,937	4,200	10,200	5,000	60			7,656
5	Jefferson	5	5,000	135	6	4,250	170	1,948	4,071	10,000	100			3,982
6	Oneida	1	2,500	45	1	1,200	70							6,244
7	Orange	12	10,316	182	12	11,384	192	50	100	2,700	360			13,708
8	Putnam	8	15,300	282	11	12,550	415	20	40					17,008
9	Richmond				1	500	15							
10	Saint Lawrence	4	8,600	164	5	3,900	164	322	544	25,000	500			3,153
11	Washington	1	500	30	1	500	35	400	800	2,500	50			1,960
12	Wayne	4	1,500	36	4	1,200	43							1,703
13	Name of county not given													

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

MISSOURI.

Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
$131,808	$8,085							*Wages* represent net wages.	
6,050	1,730							*Materials* include powder, fuel, lumber, and feed for horses and mules at $5 per head per month. To the total *lumber* (unsawed) should be added 12,000 ties, the value of which is probably included in materials. To the total	1
2,125	4,565							materials may be added $264 for half-feed of horses and mules during idle	2
	100							time of mines temporarily suspending operations during the census year.	3
								Furnaces: The following returns from mines operated by, and in connection	4
43,233								with furnaces are probably duplicated by Mr. Swank's returns: Number of mines, 9. Product, 32,734 tons; value, $72,663. Employés, 238; wages,	5
400	1,690							$50,760. Real estate, $120,000; plant, $11,495; working capital, $25,000; total capital, $156,495.	
80,000								NOTE.—"The accounts are kept so loosely at almost all the mines of this region that it has been with the utmost difficulty only that anything like a fair	6
								return could be made up.	7
								"W. B. POTTER, "*Special Agent, Saint Louis, Missouri.*"	8

NEW JERSEY.

$519,954	$15,566							*Wages* represent the net earnings of the miner. Wherever the wages were manifestly the amount paid to contractor, deductions were made for powder, etc. It is possible, however, that in some cases the "maximum" number of employés and the amount paid to contractor appear as "average" number of	
								employés and net wages, one error serving to conceal the other one.	1
20,500	750							*Materials* include explosives, lumber, fuel, etc., and feed for horses and mules,	2
420,784	5,611							the latter reckoned at $9 per head per month. To total materials should,	3
9,275	500							perhaps, be added $1,824 for half-feed of horses and mules during idle time	4
29,075	8,175							of mines temporarily suspending operations during census year.	
								Explosives, when not returned and when used, have been estimated at 13 cents per ton.	5
40,320	580							*Capital in real estate*, when not returned, has been estimated as equal to the royalty on 6 full years' production at the rate of the monthly production during the census year.	6
								Furnaces: It is to be feared that most of the ore reported as bought by furnaces from small mines was duplicated, names of middlemen appearing instead of those of operators. In view of this, and the fact that the state was very thoroughly canvassed by Special Agent J. C. Smock, a member of the New Jersey Geological Survey, it was deemed advisable to throw the irregular product out altogether. The mine schedules proper include the following mines, which are operated by and in connection with furnaces. These returns are probably duplicated by Mr. Swank in his returns. Number of mines, 21. Product, census year, 210,113 tons; value, $847,077. Employés, 1,265; wages, $416,884. Capital in real estate, $929,600; plant, $275,000; working capital, $176,250; total capital, $1,380,850. Sussex county product includes 2,500 tons, valued at $10,000, of zinc residues, *i. e.*, Franklinite from which the zinc has been extracted.	

NEW YORK.

$634,906	$30,425	200	$450	$2,500	$2,200	22,168	$155,290	*Capital in real estate*, when not returned, has been estimated as equal to the royalty on six full years' production at the rate of the monthly production during census year.	
52,200								*Wages* represent the net earnings of employés.	1
31,325								*Materials* include powder, lumber, coal or wood for fuel, tools, and feed for horses and mules, etc. To the total materials for the state may be added	2
81,900	3,200							$2,836 for half-feed of horses and mules during idle time in the case of mines	3
274,836						863	2,425	suspending operations temporarily during census year. Feed estimated at $9 per month per head, and added to materials returned.	4
15,250	12,500							*Furnaces:* Amount of ore bought by furnaces includes that mined within the state and sold to furnaces in neighboring states. Among the mine schedules	5
6,500	6,100							proper, the following represent mines worked by or in connection with furnaces, and are probably duplicated in Mr. Swank's report: Number of	6
108,875	1,425					574	1,596	mines, 9. Product, 85,987 tons; value, $214,913. Employés, 357; wages,	7
36,020	3,500							$100,282. Real estate, $273,549; plant, $142,720; working capital, $53,900; total capital, $470,169.	8
700						1,030	4,103		9
20,000	3,500	200	450	2,500	2,200	55	165		10
4,000									11
3,300	200								12
						19,646	147,001		13

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

NORTH CAROLINA.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
	The State	9	11,980	3,276	$5,102	3,318	$5,285	19		28		47
1	Catawba	1	100	50	200	52	203	1				1
2	Cherokee	4	1,300	516	895	516	895			8		8
3	Guilford	1	2,500	1,680	2,250	1,680	2,250	6		9		15
4	Lincoln	1	7,000	250	750	250	750	10		3		13
5	Mitchell	1	680	680	907	720	1,087			8		8
6	Surry	1	400	100	100	100	100	2				2

OREGON.

	The State	1	22,400	6,972	$4,669	6,972	$4,669	11		3		14
1	Clackamas	1	22,400	6,972	4,669	6,972	4,669	11		3		14

OHIO.

	The State	30	556,158	198,835	$448,000	547,403	$1,269,530	602	38	1,033	43	1,716
1	Athens					17,000	34,000					
2	Columbiana	7	122,878	46,108	87,656	56,949	110,876			301	10	311
3	Cuyahoga					1,224	7,711					
4	Gallia					680	1,500					
5	Hocking					40,740	96,846					
6	Jackson					73,423	193,065					
7	Lawrence	7	106,500	62,599	177,975	136,464	338,472	335		343		678
8	Mahoning	3	22,200	19,628	34,900	20,636	42,124	74	16	9	1	100
9	Muskingum					8,654	20,386					
10	Perry	2	27,000	10,767	19,647	69,373	159,551			117		117
11	Scioto	1	5,000	1,300	3,300	17,837	47,202			30		30
12	Stark					500	1,250					
13	Trumbull	3	40,880	11,035	34,250	12,735	37,650	73	7	12		92
14	Tuscarawas	6	196,700	30,388	55,272	72,388	139,272	95	15	111	32	253
15	Vinton	1	35,000	17,010	35,000	18,800	39,625	25		110		135

PENNSYLVANIA.

	The State	358	3,408,506	1,820,561	$4,318,999	2,185,675	$5,517,079	2,892	62	5,196	583	8,733
1	Adams	1	5,600	560	1,375	560	1,375			10		10
2	Allegheny					350	1,575					
3	Armstrong	4	26,992	11,536	20,547	31,557	76,498	87		35		122
4	Bedford	6	120,240	35,850	72,390	37,369	77,006	95		42	47	184
5	Berks	56	555,817	252,940	681,052	304,954	875,466	522	10	968	112	1,612
6	Blair	10	184,240	154,914	394,412	154,914	394,412	161	1	304	21	487
7	Bucks	4	42,560	24,192	68,280	24,192	68,280	75		8	6	89
8	Butler	4	6,450	2,318	5,130	2,318	5,130	17		17		34
9	Carbon					852	3,067					
10	Centre	1	11,200	4,875	10,883	8,935	25,399			40		40

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

NORTH CAROLINA.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
38	4	5	$4,059	$8,650	$2,750	$1,900	$13,300	1	$965	.....	.....	2	$200	
1	.....	.....	75	100	100	.....	200	.....	55	.....	.....	.....	.....	1
8	.....	.....	361	4,250	.....	100	4,350	.....	20	.....	.....	.....	.....	2
14	.....	1	1,600	2,300	1,500	1,200	5,000	.....	680	.....	.....	2	200	3
10	.....	3	1,170	400	1,000	500	1,900	.....	150	.....	.....	.....	.....	4
3	4	1	768	1,000	50	50	1,100	1	50	.....	.....	.....	.....	5
2	.....	.....	85	600	100	50	750	.....	10	.....	.....	.....	.....	6

OREGON.

11	2	1	$2,210	$9,750	$5,000	$2,225	$16,975	.....	$600	.....	.....	.....	.....	
11	2	1	2,210	9,750	5,000	2,225	16,975	.....	600	.....	.....	.....	.....	1

OHIO.

1,213	459	44	$329,723	$857,401	$263,145	$128,179	$1,248,725	8	$23,806	35	$3,500	55	$5,125	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
231	67	13	56,153	20,175	6,920	10,300	37,395	.....	1,250	.....	.....	.....	.....	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
513	158	7	137,019	567,800	197,575	53,000	818,375	5	11,470	27	2,700	28	2,800	7
87	11	2	25,859	9,450	7,950	4,250	21,650	.....	3,960	.....	.....	9	725	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
110	7	.....	15,635	91,726	3,500	4,329	99,555	2	1,164	6	600	.....	.....	10
30	.....	.....	3,300	50,000	9,000	6,500	65,500	1	1,000	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
74	13	5	29,482	13,000	16,200	6,100	35,300	.....	1,983	1	100	5	550	13
143	103	7	29,275	75,250	20,000	23,700	118,950	.....	2,129	1	.....	13	1,050	14
25	100	10	33,000	30,000	2,000	20,000	52,000	.....	850	.....	.....	.....	.....	15

PENNSYLVANIA.

4,717	3,630	386	$2,192,167	$14,759,894	$2,131,743	$730,064	$17,621,701	39	$525,165	1,327	$117,717	309	$32,755	
7	2	1	400	5,000	6,000	500	11,500	.....	94	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
107	13	2	14,948	38,385	1,200	2,730	42,315	1	882	2	200	3	300	3
141	36	7	58,497	259,000	56,100	10,850	325,950	.....	11,045	10	960	15	1,525	4
708	825	79	394,335	774,979	487,366	126,522	1,388,867	3	124,124	261	24,347	36	3,800	5
156	314	17	171,631	431,000	108,535	48,400	587,935	5	47,863	55	6,050	46	5,350	6
43	42	4	23,145	80,000	5,850	1,500	87,350	.....	4,746	3	250	.....	.....	7
27	6	1	3,672	7,200	400	1,050	8,650	.....	420	4	250	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	36	4	10,660	40,000	12,000	3,000	55,000	1	2,590	.....	.....	2	250	10

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

NORTH CAROLINA.

	Countries.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
	The State	2	$800	29	2	$550	29	30	$75	250	$5			$72
1	Catawba													50
2	Cherokee													5
3	Guilford	1	400	9	1	400	9							17
4	Lincoln	1	400	20	1	150	20	30	75					
5	Mitchell													
6	Surry									250	5			

OREGON.

	The State	1	$500	16	1	$500	16	52	$104		$304			$236
1	Clackamas	1	500	16	1	500	16	52	104		304			236

OHIO.

	The State	5	$4,925	130	13	$3,375	180			155,000	$1,900			$7,948
1	Athens													
2	Columbiana	1	225	25	3	725	35							
3	Cuyahoga													
4	Gallia													
5	Hocking													
6	Jackson													
7	Lawrence													5,987
8	Mahoning	3	3,500	85	8	2,000	90			120,000	1,200			699
9	Muskingum													
10	Perry													500
11	Scioto													
12	Stark													
13	Trumbull	1	1,200	20	2	650	55			25,000	200			278
14	Tuscarawas									10,000	500			484
15	Vinton													

PENNSYLVANIA.

	The State	380	$451,396	9,117	559	$246,080	10,864	595	$1,483	1,208,092	$29,840			$65,288
1	Adams	1	800	25	1	1,000	30							
2	Allegheny													
3	Armstrong													509
4	Bedford	1	2,000	50	1	500	50			354,500	5,575			1,775
5	Berks	97	127,520	2,737	148	69,550	3,064			108,250	7,220			12,174
6	Blair	13	16,900	624	17	14,200	800			6,926	352			7,140
7	Bucks	2	1,500	45	3	800	50			20,000	100			2,932
8	Butler									400	8			117
9	Carbon													
10	Centre	3	2,000	90	5	2,000	100							

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

NORTH CAROLINA.

Value of all machinery.	Value of buildings.	Irregular production. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
$1,850	$50	41	$183	.....	$182	.....	.....		
50	50	1	3	.....	2	.....	.....	*Capital in real estate*, when not returned, has been estimated as equal to the royalty (25 cents a ton) for six full years at the rate of the production during the census year.	1
.....	.....	.....	.....	.....	.....	.....	.....		2
800	.....	.....	.....	.....	.....	.....	.....	*Materials* include powder, fuel, lumber, and feed, the latter at the rate of $5 per head per working month.	3
1,000	.....	.....	.....	.....	.....	.....	.....		4
.....	.....	40	180	.....	180	.....	.....		5
.....	.....	.....	.....	.....	.....	.....	.....		6

OREGON.

$1,000	.....	.....	.....	.....	.....	.....	.....		
1,000	.....	.....	.....	.....	.....	.....	.....	Buildings and machinery are worth $5,000.	1

OHIO.

$8,600	$29,125	284,868	$651,949	.....	.....	63,700	$169,581		
.....	.....	17,000	34,000	.....	.....	.....	.....	*Product of mines operated by furnaces:* Among the mine schedules proper there are 10 mines operated by and in connection with furnaces. The total production of these mines during the census year is 74,666 tons; value of same, $200,922. Number of employés, 825; wages, $155,954. Value of real estate, $709,526; plant, $210,075; working capital, $63,029; total capital, $983,430. These amounts are probably duplicated in Mr. Swank's report.	1
1,050	.....	.....	.....	.....	.....	10,841	23,220		2
.....	.....	.....	.....	.....	.....	1,224	7,711		3
.....	.....	680	1,500	.....	.....	.....	.....		4
.....	.....	35,142	81,326	.....	.....	5,598	15,520	*Materials* include feed at $5 per head per month, and powder, lumber, etc. To total materials may be added for half-feed in idle time, $572 50. Wages are probably gross as a rule, it being difficult to arrive at the exact outlay of miners for tools, etc.	5
.....	.....	47,157	117,883	.....	.....	26,266	75,182		6
.....	27,000	72,973	157,173	.....	.....	892	3,324		7
4,000	1,300	112	224	.....	.....	896	7,000		8
.....	.....	8,654	20,386	.....	.....	.....	.....		9
.....	.....	42,723	107,180	.....	.....	15,883	32,724		10
.....	.....	16,537	43,902	.....	.....	.....	.....		11
.....	.....	500	1,250	.....	.....	.....	.....		12
3,550	825	300	600	.....	.....	1,400	2,800		13
.....	.....	42,000	84,000	.....	.....	.....	.....		14
.....	.....	1,090	2,525	.....	.....	700	2,100		15

PENNSYLVANIA.

$934,658	$307,182	100,957	$318,953	$101,731	$224,077	264,157	$879,127	*Product of mines operated by furnaces:* Among the "mine schedules" proper there are 125 mines operated by and in connection with furnaces. The aggregate production of such mines is 706,339 tons, valued at $1,672,024. The total number of employés in the same is 4,194. The total amount of wages paid is $1,134,374. The capital, real and personal: Real, $3,149,183; plant, $828,678; working, $364,580; total capital, $4,342,441. These amounts are probably duplicated in Mr. Swank's report.	
2,100	800	.....	.....	.....	.....	.....	.....		1
.....	.....	.....	.....	.....	.....	350	1,575		2
.....	.....	.....	.....	.....	.....	20,021	55,951		3
7,000	2,200	.....	.....	.....	.....	1,519	4,616	*Capital in real estate:* When no return or estimate could be obtained from the operator or owner the value has been estimated as equal to the sum of the royalty on the product of six full years, calculated from the average monthly production of the census year.	4
260,968	61,348	14,812	56,551	13,000	54,618	37,202	137,863		5
42,370	14,800	.....	.....	.....	.....	.....	.....	*Wages* represent net earnings of employés.	6
2,800	750	.....	.....	.....	.....	.....	.....	*Materials* include coal, powder, fuse, lumber, oil, iron, rails, etc., and feed for horses and mules. The latter has been estimated at $7 per head per working month. To the total materials should be added for half-feed of animals during idle time of mines $8,146.	7
.....	.....	.....	.....	.....	.....	.....	.....		8
.....	.....	.....	.....	.....	.....	852	3,067		9
10,000	600	4,004	14,303	6,000	10,726	56	213		10

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
11	Chester	5	24,452	10,687	31,309	14,037	40,801	50	.....	48	9	107
12	Clarion	11	59,480	15,369	28,798	15,705	30,142	114	.....	74	.....	188
13	Columbia	.....	.....	.....	.....	22,588	75,788	.....	.....	.....	.....	.....
14	Cumberland	19	218,500	67,846	151,972	76,338	180,617	15	.....	447	22	484
15	Dauphin	2	9,480	2,016	3,600	3,132	7,913	.....	.....	26	5	31
16	Fayette	4	109,136	63,792	147,691	76,140	183,433	272	9	84	4	369
17	Franklin	11	92,602	34,458	86,998	36,614	92,076	31	10	201	25	267
18	Huntingdon	4	68,320	25,245	61,407	26,113	65,736	50	.....	46	7	103
19	Juniata	7	57,234	34,378	69,835	35,729	73,923	70	.....	38	.....	108
20	Lancaster	9	102,704	63,274	134,583	78,850	184,919	.....	.....	241	28	269
21	Lawrence	16	187,336	60,201	123,226	70,296	153,546	158	6	66	.....	230
22	Lebanon	4	297,102	285,629	514,329	285,629	514,329	.....	.....	184	14	198
23	Lehigh	66	524,604	321,322	880,818	419,700	1,201,920	217	.....	1,434	196	1,847
24	Lycoming	3	14,224	4,948	6,988	5,374	8,479	33	.....	12	.....	45
25	Mercer	.....	.....	.....	.....	1,008	7,200	.....	.....	.....	.....	.....
26	Mifflin	15	70,805	34,152	70,194	53,699	119,800	129	4	82	3	218
27	Montgomery	15	62,832	41,881	92,247	94,387	268,738	103	.....	110	10	223
28	Montour	8	63,440	30,741	47,677	33,890	58,400	133	13	8	3	157
29	Northampton	35	144,799	104,788	267,161	122,526	327,068	140	.....	282	40	462
30	Northumberland	2	17,360	2,016	4,600	6,142	16,728	16	.....	8	.....	24
31	Perry	10	59,838	39,153	107,109	39,384	107,986	134	5	82	21	242
32	Snyder	7	95,648	27,381	54,904	31,426	68,066	118	.....	29	.....	147
33	Tioga	.....	.....	.....	.....	100	250	.....	.....	.....	.....	.....
34	Union	1	2,000	529	1,062	809	1,893	8	.....	6	.....	14
35	York	18	173,511	63,570	178,422	70,058	199,120	144	4	264	10	422

TENNESSEE.

	The State	34	218,254	89,933	$129,951	104,465	$147,181	77	.....	443	32	552
1	Blount	1	5,670	2,342	3,098	2,342	3,098	4	.....	7	.....	11
2	Bradley	3	25,081	9,931	12,625	9,931	12,625	.....	.....	71	.....	71
3	Carter	5	5,934	4,445	10,131	4,445	10,131	.....	.....	36	.....	36
4	Dixon	2	12,474	10,773	18,892	10,773	18,892	.....	.....	83	15	98
5	Hamblin	1	11,200	5,600	15,000	5,600	15,000	.....	.....	35	5	40
6	James	5	29,305	13,235	15,125	13,235	15,125	.....	.....	73	2	75
7	Johnson	10	6,790	3,060	3,260	3,060	3,260	5	.....	35	.....	40
8	Lawrence	1	11,340	641	565	641	565	.....	.....	25	.....	25
9	Meigs	1	11,340	10,206	13,500	10,206	13,500	15	.....	7	.....	22
10	Rhea	1	34,020	13,608	18,000	13,608	18,000	30	.....	8	.....	38
11	Roane	3	38,220	15,049	18,126	29,581	35,356	23	.....	43	5	71
12	Stewart	1	26,880	1,043	1,629	1,043	1,629	.....	.....	20	5	25

TEXAS.

	The State	.....	.....	.....	.....	3,600	$8,100	.....	.....	.....	.....	.....
1	Marion	.....	.....	.....	.....	3,600	8,100	.....	.....	.....	.....	.....

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

PENNSYLVANIA—Continued.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
35	67	5	29,463	19,000	20,675	7,400	47,075	.....	11,205	18	1,575	.....	.....	11
166	16	6	22,982	77,456	5,120	5,705	88,281	2	1,542	10	825	11	1,000	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
321	143	20	65,023	336,633	143,023	37,933	517,589	2	22,530	52	3,780	15	1,475	14
2	28	1	2,638	20,000	3,500	3,000	26,500	.....	900	10	1,000	.....	.....	15
277	84	8	131,806	411,000	33,000	25,000	469,000	2	20,318	11	895	44	4,250	16
167	86	14	49,458	86,766	56,633	22,666	166,065	4	11,795	41	2,640	13	1,260	17
44	51	8	39,307	1,140,000	58,779	20,000	1,218,779	3	8,224	18	1,350	10	1,000	18
60	44	4	32,209	38,000	6,000	6,700	50,700	.....	3,092	6	450	20	1,805	19
114	141	17	61,563	289,000	54,450	15,820	359,270	.....	14,268	42	3,750	16	1,410	20
163	54	13	96,156	130,000	8,900	14,600	153,500	4	6,704	17	1,305	6	600	21
27	162	9	48,459	8,017,500	210,000	102,650	8,330,150	.....	14,526	6	300	.....	.....	22
991	783	73	422,903	1,064,887	498,400	149,042	1,712,329	.....	131,266	462	40,775	19	3,350	23
30	12	3	9,718	8,200	3,686	5,320	17,206	.....	2,934	16	2,750	.....	.....	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
155	47	16	37,818	58,350	39,510	8,696	106,556	5	5,896	26	2,400	3	110	26
78	137	8	54,632	226,200	25,650	12,000	263,850	.....	11,280	38	3,305	1	100	27
137	13	7	55,046	112,555	47,507	17,240	177,302	5	8,516	3	325	3	85	28
231	203	28	150,008	264,618	96,421	27,030	388,069	.....	31,051	132	640	.....	.....	29
16	7	1	2,334	24,445	488	1,300	26,233	.....	177	.....	.....	.....	.....	30
185	45	12	81,502	535,500	27,200	27,125	589,825	1	5,901	9	640	28	3,350	31
116	28	3	32,441	57,220	10,975	5,260	73,455	.....	4,604	22	2,055	11	960	32
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	33
8	5	1	435	1,000	600	150	1,750	1	162	7	525	.....	.....	34
205	200	17	88,973	206,000	103,775	20,875	330,650	.....	16,510	46	4,400	7	775	35

TENNESSEE.

419	109	24	$83,529	$410,450	$36,095	$27,375	$473,920	14	$8,679	22	$1,600	84	$10,100	
10	.....	1	6,450	.....	1,000	1,000	2,000	.....	200	.....	.....	2	200	1
66	2	3	7,480	12,300	1,900	5,600	19,800	1	310	2	200	6	600	2
22	14	.....	6,800	8,800	1,425	1,400	11,625	1	1,040	10	900	.....	.....	3
95	.....	3	16,631	65,000	5,000	4,000	74,000	2	885	.....	.....	16	2,000	4
30	9	1	5,500	10,000	500	500	11,000	.....	716	6	200	.....	.....	5
59	11	5	9,125	25,950	3,670	2,850	32,470	3	2,343	4	300	22	2,500	6
23	17	.....	2,642	11,900	2,100	1,325	15,325	1	377	.....	.....	.....	.....	7
20	5	.....	1,100	17,500	3,000	500	21,000	1	150	.....	.....	10	1,500	8
8	12	2	5,000	7,000	2,000	1,000	10,000	1	300	.....	.....	3	300	9
15	20	3	9,000	30,000	7,000	3,000	40,000	1	1,000	.....	.....	7	900	10
53	14	4	12,301	38,000	6,500	5,200	49,700	3	650	.....	.....	12	1,200	11
18	5	2	1,500	184,000	2,000	1,000	187,000	.....	708	.....	.....	6	900	12

TEXAS.

.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
11	Chester	9	7,500	170	11	4,800	201			6,000	240			918
12	Clarion									8,600	172			232
13	Columbia													
14	Cumberland	26	26,400	546	25	10,250	569	231	407	4,800	220			733
15	Dauphin	2	900	25	2	400	25							12
16	Fayette	1	400	20	1	160	30							7,191
17	Franklin	13	14,500	283	15	8,550	337	348	1,044	2,800	52			230
18	Huntingdon	2	2,000	80	3	1,500	100	6	12	54,500	1,025			565
19	Juniata									3,575	220			328
20	Lancaster	19	23,050	485	22	7,800	450			500	20			100
21	Lawrence							10	20	3,800	56			1,985
22	Lebanon	3	2,450	82	6	1,650	105							5,814
23	Lehigh	124	158,626	2,574	204	85,900	3,379			148,550	8,880			13,513
24	Lycoming									12,500	500			634
25	Mercer													
26	Mifflin	5	9,000	63	5	1,350	75			142,500	1,200			1,221
27	Montgomery	6	6,850	179	9	3,950	179			20,416	425			37
28	Montour	4	6,900	235	13	5,100	240			7,000	315			4,388
29	Northampton	28	28,050	421	43	16,620	617			213,775	2,229			68
30	Northumberland													
31	Perry	3	3,000	75	4	1,500	74			61,000	820			309
32	Snyder									19,000	88			400
33	Tioga													
34	Union									120	5			10
35	York	18	11,050	308	21	8,500	389			8,580	118			1,953

TENNESSEE.

	The State									18,000	$900			$1,209
1	Blount									2,000	100			
2	Bradley													10
3	Carter													
4	Dixon													360
5	Hamblin													
6	James													791
7	Johnson													
8	Lawrence													
9	Meigs									4,000	200			
10	Rhea									10,000	500			
11	Roane									2,000	100			38
12	Stewart													10

TEXAS.

	The State													
1	Marion													

TABLE 14.—*Statistics of the production of iron ore, by states and counties*—Continued.

PENNSYLVANIA—Continued.

Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
15,000	1,300					3,350	9,492	*Cambria county:* The only iron mines in this county are those of the Cambria Iron Company, which produce ordinarily about 30,000 tons (carbonate) per annum, but which were idle during the census year.	11
						336	1,344		
		22,588	75,788	41,500	62,045				12
52,933	18,116	4,400	13,200	4,400	10,000	4,092	15,445		13
1,800	2,000	1,060	4,248	500	2,385	56	65		14
									15
						12,348	35,742		
29,066	14,949					2,156	5,078		16
13,200	4,700					868	4,329		17
	200					1,351	4,088		18
34,700	4,850	5,052	11,843	6,700	9,000	10,524	38,493		19
									20
2,600						10,095	30,320		
18,600	550								21
311,876	138,378	20,893	62,670	10,000	41,786	77,485	258,432		22
	600					426	1,491		23
						1,008	7,200		24
									25
12,975	900	17,860	44,650	2,536	4,006	1,687	4,956		
13,500	4,700	6,008	22,530	9,500	19,512	46,498	153,961		26
12,000	2,800					3,149	10,723		27
61,110	12,361	732	2,798		1,799	17,006	57,109		28
		3,448	10,122	95	8,050	678	2,00		29
									30
6,100	6,880					231	877		
	1,000					4,045	13,162		31
		100	250	7,500	150				32
						280	831		33
24,560	12,400					6,488	20,698		34
									35

TENNESSEE.

	$1,370	13,732	$16,630			800	$600		
								Capital in real estate, when not returned, has been estimated as equal to the royalty on six full years' production at the rate of the monthly production during the census year.	1
									2
								Wages represent net wages.	3
								Materials include, powder, fuze, lumber, etc., and feed for horses, mules, and oxen. The latter has been estimated at $6 per month per head and added to returns for materials. To total materials should perhaps be added for half-feed of animals (horses and mules) during idle time of mines temporarily suspending operations during the census year, $1,873.	4
									5
	120								6
								Oxen: Beside horses and mules 10 oxen were returned, valued at $355.	7
								Furnaces: The following returns from mines operated by aud in connection with furnaces are probably duplicated by Mr. Swank's report. Number of mines, 11. Product, 24,844 tons; value, $49,315. Employés, 235; wages, $37,981. Real estate, $285,300; plant, $12,925; working capital, $8,400; total capital, $306,625.	8
									9
									10
	1,250	13,732	16,630			800	600		11
									12

TEXAS.

		3,600	$8,100	$50	$7,200				
		3,600	8,100	50	7,200				1

TABLE 14.—*Production of iron ore, by states and counties*—Continued.

VERMONT.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
		1	2	3	4	5	6	7	8	9	10	11
			Tons.	*Tons.*		*Tons.*						
	The State	1	1,120	560	$2,750	560	$2,750	7	.....	8	.....	15
1	Franklin	1	1,120	560	2,750	560	2,750	7	.....	8	.....	15

VIRGINIA.

	The State	26	1,404,524	169,633	$384,331	182,326	$439,886	338	10	555	36	939
1	Albemarle	.....	.....	.....	.....	53	200	.....	.....	.....	.....	.....
2	Alleghany	8	174,720	61,106	125,243	61,106	125,243	103	1	190	18	312
3	Amherst	3	224,000	10,640	42,750	10,640	42,750	76	1	60	2	148
4	Augusta	2	85,120	16,652	33,315	16,762	33,823	49	3	132	5	189
5	Bedford	.....	.....	.....	.....	500	750	.....	.....	.....	.....	.....
6	Botetourt	2	268,800	28,225	63,003	28,225	63,003	30	2	50	3	85
7	Campbell	1	84	84	150	308	934	5	.....	.....	4	9
8	Louisa	.....	.....	.....	.....	14	173	.....	.....	.....	.....	.....
9	Nelson	1	56,000	3,360	15,000	3,360	15,000	30	.....	30	.....	60
10	Pittsylvania	.....	.....	.....	.....	11,292	50,814	.....	.....	.....	.....	.....
11	Rockingham	2	187,000	31,360	64,000	31,360	64,000	5	.....	48	2	55
12	Shenandoah	2	156,800	7,840	14,220	7,856	14,283	26	3	6	2	37
13	Wythe	5	252,000	10,416	26,650	10,416	26,650	14	.....	30	.....	44
14	Name of county not given	.....	.....	.....	.....	434	2,263	.....	.....	.....	.....	.....

WEST VIRGINIA.

	The State	8	140,520	60,371	$88,595	61,216	$91,057	150	.....	114	2	266
1	Braxton	1	5,000	2,500	3,333	2,500	3,333	9	.....	1	.....	10
2	Hampshire	1	8,500	7,000	10,500	7,000	10,500	.....	.....	25	.....	25
3	Hardy	1	6,720	448	400	448	400	6	.....	.....	.....	6
4	Kanawha	.....	.....	.....	.....	845	2,462	.....	.....	.....	.....	.....
5	Morgan	1	16,800	2,800	5,000	2,800	5,000	.....	.....	29	1	30
6	Preston	3	75,500	33,825	44,722	33,825	44,722	85	.....	44	1	130
7	Taylor	1	28,000	13,798	24,640	13,798	24,640	50	.....	15	.....	65

WISCONSIN.

	The State	2	45,600	41,440	$73,000	41,440	$73,000	20	2	37	3	62
1	Dodge	1	40,000	39,200	70,000	39,200	70,000	20	2	29	3	54
2	Sauk	1	5,600	2,240	3,000	2,240	3,000	.....	.....	8	.....	8

TABLE 14.—*Production of iron ore, by states and counties*—Continued.

VERMONT.

EMPLOYÉS.				CAPITAL.										
Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	
15	.....	.....	$1,500	$1,000	$500	$500	$2,000	.....	$536	1	$100	.....	.....	
15	.....	.....	1,500	1,000	500	500	2,000	.....	536	1	100	.....	.....	1

VIRGINIA.

412	438	89	$186,279	$1,496,500	$206,000	$106,625	$1,809,125	24	$37,783	106	$10,175	148	$16,675	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
122	150	40	86,950	302,000	62,400	36,600	401,000	8	15,655	13	1,400	55	6,350	2
75	61	12	16,100	152,000	50,000	6,500	208,500	2	3,602	41	4,075	25	2,475	3
107	70	12	39,851	200,000	26,000	22,000	248,000	2	6,804	6	800	16	2,300	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
4	74	7	8,400	200,000	10,000	9,700	219,700	2	1,225	1	75	1	100	6
5	3	1	300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
30	20	10	3,600	50,000	30,000	2,500	82,500	1	2,212	.....	.....	12	1,200	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
15	38	2	14,000	415,000	8,100	10,000	433,100	2	2,160	3	150	26	2,950	11
26	9	2	8,838	90,000	12,000	12,000	114,000	2	2,375	10	850	8	800	12
28	13	3	8,240	87,500	7,500	7,325	102,325	5	3,750	32	2,825	5	500	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14

WEST VIRGINIA.

165	93	8	$63,985	$88,500	$16,550	$10,450	$115,500	3	$5,061	22	$1,200	9	$800	
9	.....	1	1,950	4,500	500	350	5,350	.....	200	.....	.....	.....	.....	1
9	15	1	6,500	10,000	6,000	1,000	17,000	.....	500	.....	.....	.....	.....	2
6	.....	.....	300	25,000	50	100	25,150	1	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
15	14	1	2,250	5,000	1,500	1,500	8,000	.....	234	18	900	.....	.....	5
81	47	2	33,571	38,000	6,500	5,000	49,500	2	3,356	4	300	7	700	6
45	17	3	19,414	6,000	2,000	2,500	10,500	.....	771	.....	.....	2	100	7

WISCONSIN.

33	28	1	$17,000	$160,000	$10,000	$16,000	$186,000	1	$2,250	10	$950	4	$200	
25	28	1	15,000	60,000	5,000	6,000	71,000	.....	2,000	3	350	4	200	1
8	.....	.....	2,000	100,000	5,000	10,000	115,000	1	250	7	600	.....	.....	2

TABLE 14.—*Production of iron ore, by states and counties*—Continued.

VERMONT.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.
		26	27	28	29	30	31	32	33	34	35	36	37	38
								Cords.		*Lin. feet.*		*Ft. B. M.*		
	The State													$138
1	Franklin													138

VIRGINIA.

	The State	8	$13,025	154	11	$8,600	199	6,400	$2,384	611,660	$6,110			$13,165
1	Albemarle													
2	Alleghany	3	8,000	50	4	2,400	50			571,660	5,710			6,968
3	Amherst													1,918
4	Augusta	1	325	20	1	500	20							1,842
5	Bedford													
6	Botetourt													738
7	Campbell													
8	Louisa													
9	Nelson	1	2,500	15	3	3,000	50	900	1,260					398
10	Pittsylvania													
11	Rockingham	2	1,200	39	2	1,700	39	300	450	5,000	50			304
12	Shenandoah							5,000	300	18,000	130			473
13	Wythe	1	1,000	30	1	1,000	40	200	374	17,000	220			524
14	Name of county not given													

WEST VIRGINIA.

	The State													$1,226
1	Braxton													
2	Hampshire													
3	Hardy													
4	Kanawha													
5	Morgan													84
6	Preston													917
7	Taylor													225

WISCONSIN.

	The State	1	$2,000	25	2	$1,000	50							$225
1	Dodge	1	2,000	25	2	1,000	50							75
2	Sauk													150

TABLE 14.—*Production of iron ore, by states and counties*—Continued.

VERMONT.

Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	Remarks.	
39	40	41	42	43	44	45	46		
		Tons.				*Tons.*			
$225									
225									1

VIRGINIA.

$37,785		500	$750			12,143	$54,805		
						53	200	*Wages* represent the net earnings of the employés, the operators furnishing all the powder, oil, tools, etc.	1
21,000									2
25								*Materials:* To original returns has been added $6 per working month, per mule or horse, for feed. To total materials for the state may be added for half-feed of animals during idle time of mines temporarily suspending operations during the census year, $4,044.	3
1,010						110	508		4
		500	750						5
								Capital in real estate, when not returned, has been estimated equal to the royalty on six full years' production at the rate of the monthly production during the census year.	6
						224	784	*Furnaces:* The returns from mine schedules include the following, which are probably duplicated in Mr. Swank's returns: Number of mines, 4. Product, census year, 28,066 tons; value, $50,838. Employés, 95; wages, $21,217. Real estate, $104,500; plant, $7,000; working capital, $8,925; total capital, $120,425.	7
						14	173		8
10,000									9
						11,292	50,814		10
3,600									11
650						16	63		12
1,500									13
						434	2,263		14

WEST VIRGINIA.

$1,500	$2,000					845	$2,462	*Wages* represent the net earnings of the employés, the operators furnishing the powder, oil, tools, etc.	
								Materials: To original returns has been added $6 per working-month, per mule or horse, for feed. To total materials for the state may be added $5 59 for half-feed of horses and mules during idle time of mines temporarily suspending operations during census year.	1
1,500									2
								Capital in real estate, when not returned, has been estimated as equal to the royalty on six full years' production at the rate of the monthly production during census year.	3
						845	2,462		4
								Furnaces: The returns from mine schedules include the following, which are probably duplicated in Mr. Swank's returns: Number of mines, 5. Products, census year, 57,898 tons; value, $82,873. Employés, 207; wages, $60,364. Real estate, $43,500; plant, $14,000; working capital, $8,300; total capital, $65,850.	5
	2,000								6
									7

WISCONSIN.

$3,000									
3,000									1
									2

TABLE 15.—*Statistics of the production of iron ore, by states.*

[NOTE.—With the exception of columns 5 and 6, in which the regular and irregular product are

	States.	Number of counties reporting.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year, i. e., product of establishments and irregular product together.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.
		0	1	2	3	4	5	6	7	8	9
				Tons.	*Tons.*		*Tons.*				
	Total	160	805	13,462,917	7,064,829	$20,470,756	7,974,806	$23,156,957	13,735	249	16,345
1	Alabama	10	17	310,109	184,110	189,108	191,676	201,865	109	6	590
2	Connecticut	1	4	45,800	35,018	147,799	35,018	147,799	20	.....	179
3	Delaware	1	2	18,389	2,726	6,553	2,726	6,553	.....	.....	36
4	Georgia	3	7	101,157	72,705	120,692	91,416	143,622	50	.....	287
5	Kentucky	9	5	105,420	33,522	88,930	64,809	165,905	45	.....	255
6	Indiana	1	.....	.....	.....	.....	513	1,018	.....	.....	.....
7	Maine	1	1	12,000	6,000	9,000	6,000	9,000	.....	.....	20
8	Maryland	11	13	145,296	57,940	118,050	139,628	421,691	12	.....	295
9	Massachusetts	1	9	87,360	62,637	226,130	62,637	226,130	224	.....	134
10	Michigan	2	43	2,223,365	1,837,712	6,034,648	1,837,712	6,034,648	3,120	17	2,229
11	Missouri	8	48	968,001	386,197	1,674,875	386,197	1,674,875	358	10	1,435
12	New Jersey	6	109	1,487,829	754,872	2,900,442	757,372	2,910,442	3,264	69	1,385
13	New York	13	78	2,149,129	1,239,759	3,499,132	1,262,127	3,654,872	2,417	35	2,083
14	North Carolina	6	9	11,980	3,276	5,102	3,318	5,285	19	.....	28
15	Oregon	1	1	22,400	6,972	4,669	6,972	4,669	11	.....	3
16	Ohio	15	30	556,158	198,835	448,000	547,403	1,269,530	602	38	1,033
17	Pennsylvania	35	358	3,408,506	1,820,561	4,318,999	2,185,675	5,517,079	2,892	62	5,196
18	Tennessee	12	34	218,254	89,933	129,951	104,465	147,181	77	.....	443
19	Texas	1	.....	.....	.....	.....	3,600	8,100	.....	.....	.....
20	Vermont	1	1	1,120	560	2,750	560	2,750	7	.....	8
21	Virginia	13	26	1,404,524	169,683	384,331	182,326	439,886	338	10	555
22	West Virginia	7	8	140,520	60,371	88,595	61,216	91,057	150	.....	114
23	Wisconsin	2	2	45,600	41,440	73,000	41,440	73,000	20	2	37

TABLE 15.—*Statistics of the production of iron ore, by states.*

combined, all the questions in columns 1 to 40, both inclusive, relate to regular establishments only.]

EMPLOYÉS.						CAPITAL.							
Boys employed above ground.	Total number of employés.	Number of miners.	Number of laborers.	Number of administrative force.	Total wages paid.	Value of real estate.	Value of plant.	Amount used as working capital.	Total capital employed and invested.	Number of mining company's stores.	Value of all materials used.	Number of horses.	
10	11	12	13	14	15	16	17	18	19	20	21	22	
1,339	31,668	17,923	12,492	1,253	$9,538,117	$48,274,149	$8,657,375	$4,850,763	$61,782,287	175	$2,894,011	2,744	
33	738	503	216	19	123,342	438,772	46,770	50,900	536,442	9	17,625	a73	1
1	200	100	90	10	61,167	368,000	39,800	18,500	426,300	.....	20,853	98	2
11	47	20	25	2	2,865	40,000	6,300	2,000	48,300	.....	941	6	3
5	342	217	105	20	108,796	101,200	33,935	35,790	170,925	4	8,345	.....	4
25	325	224	88	13	69,319	678,329	59,500	42,000	779,829	2	8,100	91	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	20	12	8	.....	9,000	2,500	2,000	2,000	6,500	.....	3,150	16	7
22	329	119	192	18	61,138	310,600	135,464	44,450	490,514	2	23,726	37	8
24	382	216	156	10	117,158	183,000	70,600	22,400	276,000	.....	43,136	50	9
196	5,562	3,163	2,189	210	2,573,857	12,452,311	2,789,944	2,254,520	17,496,775	14	939,711	390	10
90	1,893	1,126	690	77	417,371	4,666,223	678,313	254,020	5,598,556	7	104,955	67	11
93	4,811	2,931	1,754	126	1,606,257	4,797,620	841,226	562,915	6,201,761	23	584,229	70	12
140	4,675	2,269	2,216	190	1,507,395	6,443,449	1,281,740	537,950	8,263,139	24	534,395	323	13
.....	47	38	4	5	4,059	8,650	2,750	1,900	13,300	1	965	.....	14
.....	14	11	2	1	2,210	9,750	5,000	2,225	16,975	.....	600	.....	15
43	1,716	1,213	459	44	329,723	857,401	263,145	128,179	1,248,725	8	23,806	35	16
583	8,733	4,717	3,630	386	2,192,167	14,759,894	2,131,743	730,064	17,621,701	39	525,165	1,327	17
32	552	419	109	24	83,529	410,450	36,095	27,375	473,920	14	8,679	22	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	15	15	.....	.....	1,500	1,000	500	500	2,000	.....	536	1	20
36	939	412	438	89	186,279	1,496,500	206,000	106,625	1,809,125	24	37,783	106	21
2	266	165	93	8	63,985	88,500	16,550	10,450	115,500	3	5,061	22	22
3	62	33	28	1	17,000	160,000	10,000	16,000	186,000	1	2,250	10	23

a Includes 64 oxen.

TABLE 15.—*Statistics of the production of iron ore, by states*—Continued.

	States.	Value of horses.	Number of mules.	Value of mules.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of wood used for fuel.	Value of cord-wood.
		23	24	25	26	27	28	29	30	31	32	33
											Cords.	
	Total	$287,567	1,249	$142,935	821	$1,061,882	24,838	1,093	$643,846	28,422	88,743	$178,059
1	Alabama	2,835	107	11,070	6	4,550	192	6	2,250	192	1,536	2,680
2	Connecticut	11,950			5	2,200	105	6	5,200	135	5	25
3	Delaware	400	16	1,140	4	2,500	40	3	1,300	28	23	53
4	Georgia		68	8,650				1	300	20		
5	Kentucky	8,300	26	1,500								
6	Indiana											
7	Maine	1,600										
8	Maryland	5,600	45	6,100	11	9,600	263	11	7,200	263	910	2,000
9	Massachusetts	6,575	2	200	8	9,600	220	19	13,450	455		
10	Michigan	64,350	37	4,670	134	210,850	6,574	125	108,852	6,209	52,045	116,969
11	Missouri	5,015	241	31,370	17	31,800	448	24	20,150	594	6,447	15,157
12	New Jersey	6,665	48	5,500	152	195,945	4,486	192	110,005	4,921	2	8
13	New York	39,035	48	6,880	87	121,591	3,039	118	115,034	4,267	20,698	37,121
14	North Carolina		2	200	2	800	29	2	550	29	30	75
15	Oregon				1	500	16	1	500	16	52	104
16	Ohio	3,500	55	5,125	5	4,925	130	13	3,375	180		
17	Pennsylvania	117,717	309	32,755	380	451,396	9,117	559	246,080	10,864	595	1,483
18	Tennessee	1,600	84	10,100								
19	Texas											
20	Vermont	100										
21	Virginia	10,175	148	16,675	8	13,025	154	11	8,600	199	6,400	2,384
22	West Virginia	1,200	9	800								
23	Wisconsin	950	4	200	1	2,000	25	2	1,000	50		

TABLE 15.—*Statistics of the production of iron ore, by states*—Continued.

Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Cost of explosives.	Value of all machinery.	Value of buildings.	IRREGULAR PRODUCTION. Mined by furnaces. Product, census year.	Value of product.	Value of tools and machinery.	Estimated value of labor in producing and bringing to furnace.	Bought by furnaces. From small mines within the county, census year.	Amount paid for this ore.	
34	35	36	37	38	39	40	41	42	43	44	45	46	
Lin. feet.		*Ft. B. M.*					*Tons.*				*Tons.*		
6,912,931	$115,305	6,878,000	$95,244	$484,452	$3,211,548	$426,703	412,419	$1,019,414	$107,881	$243,753	494,956	$1,656,787	
31,000	310	.....	.....	4,240	17,765	6,050	.....	.....	.....	.....	7,566	12,757	1
2,100	105	20,000	325	3,669	22,225	.....	.....	.....	.....	.....	.....	.....	2
.....	.....	.....	.....	3	4,400	150	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	4,200	1,250	16,800	.....	.....	.....	.....	18,711	22,930	4
10,000	500	.....	.....	1,470	.....	.....	4,940	10,155	.....	6,000	26,347	66,820	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	512	1,018	6
.....	.....	.....	.....	2,000	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	789	17,164	9,900	3,581	12,244	3,600	4,094	78,107	291,397	8
33,628	2,354	25,000	350	6,818	34,900	.....	.....	.....	.....	.....	.....	.....	9
3,571,000	25,381	6,833,000	94,569	160,561	838,558	.....	.....	.....	.....	.....	.....	.....	10
155,000	2,300	.....	.....	28,972	131,808	8,085	.....	.....	.....	.....	.....	.....	11
1,067,751	43,976	.....	.....	105,130	519,954	15,566	.....	.....	.....	.....	.....	.....	12
49,450	1,320	.....	.....	77,093	634,906	30,425	200	450	2,500	2,200	22,168	155,290	13
250	5	.....	.....	72	1,850	50	41	183	.....	182	.....	.....	14
.....	304	.....	.....	236	1,000	.....	.....	.....	.....	.....	.....	.....	15
155,000	1,900	.....	.....	7,948	8,600	29,125	284,868	651,949	.....	.....	63,600	169,581	16
1,208,092	29,840	.....	.....	65,288	934,658	307,182	100,957	318,953	101,731	224,077	264,157	879,127	17
18,000	900	.....	.....	1,209	.....	1,370	13,732	16,630	.....	.....	800	600	18
.....	.....	.....	.....	.....	.....	.....	3,600	8,100	50	7,200	.....	.....	19
.....	.....	.....	.....	138	225	.....	.....	.....	.....	.....	.....	.....	20
611,660	6,110	.....	.....	13,165	37,785	.....	500	750	.....	.....	12,143	54,805	21
.....	.....	.....	.....	1,226	1,500	2,000	.....	.....	.....	.....	845	2,462	22
.....	.....	.....	.....	225	3,000	.....	.....	.....	.....	.....	.....	.....	23

GENERAL ANALYSIS OF

By C. F.

TABLE 16.—*Production of iron*

	Name of State.	Number of counties reporting.	Number of establishments.	Maximum yearly capacity of production of working establishments.	Product of establishments, census year.	Value of product of establishments.	Irregular product, census year.	Total product, census year.	Value of total product.	Value of all materials used in regular industry.	Wages paid in establishments of regular industry.	Men employed above ground.	Men employed below ground.	Boys under 16 employed above ground.
		1	2	3	4	5	6	7	8	9	10	11	12	13
				Tons.	*Tons.*		*Tons.*	*Tons.*						
	The United States	135	805	13, 462, 917	7, 064, 829	$20, 470, 756	909, 977	7, 974, 806	$23, 156, 957	$2, 894, 011	$9, 538, 117	16, 345	13, 735	1, 339
1	Alabama	10	17	310, 109	184, 110	189, 108	7, 566	191, 676	201, 865	17, 625	123, 342	500	109	33
2	Connecticut	1	4	45, 800	35, 018	147, 799	.....	35, 018	147, 799	20, 853	61, 167	179	20	1
3	Delaware	1	2	18, 389	2, 726	6, 553	.....	2, 726	6, 553	941	2, 865	36	.....	11
4	Georgia	3	7	101, 157	72, 705	120, 692	18, 711	91, 416	143, 622	8, 345	108, 796	287	50	5
5	Kentucky	4	5	105, 420	33, 522	88, 930	31, 287	64, 809	165, 905	8, 100	69, 319	255	45	25
6	Indiana	1	...	.....	.....	.....	513	513	1, 018	.....	.....	.....	.....	.....
7	Maine	1	1	12, 000	6, 000	9, 000	.....	6, 000	9, 000	3, 150	9, 000	20	.....	.....
8	Maryland	5	13	145, 296	57, 940	118, 050	81, 688	139, 628	421, 691	23, 726	61, 138	295	12	22
9	Massachusetts	1	9	87, 360	62, 637	226, 130	.....	62, 637	226, 130	43, 136	117, 158	134	224	24
10	Michigan	2	43	2, 223, 365	1, 837, 712	6, 034, 648	.....	1, 837, 712	6, 034, 648	939, 711	2, 573, 857	2, 229	3, 120	196
11	Missouri	8	48	968, 001	386, 197	1, 674, 875	.....	386, 197	1, 674, 875	104, 955	417, 371	1, 435	358	90
12	New Jersey	6	109	1, 487, 829	754, 872	2, 900, 442	2, 500	757, 372	2, 910, 442	584, 229	1, 606, 257	1, 385	3, 264	93
13	New York	12	78	2, 149, 129	1, 239, 759	3, 499, 132	22, 368	1, 262, 127	3, 654, 872	534, 395	1, 507, 395	2, 083	2, 417	140
14	North Carolina	6	9	11, 980	3, 276	5, 102	42	3, 318	5, 285	965	4, 059	28	19	.....
15	Oregon	1	1	22, 400	6, 972	4, 669	.....	6, 972	4, 669	600	2, 210	3	11	.....
16	Ohio	8	30	556, 158	198, 835	448, 000	348, 568	547, 403	1, 269, 530	23, 806	329, 723	1, 033	602	43
17	Pennsylvania	34	358	3, 408, 506	1, 820, 561	4, 318, 999	365, 114	2, 185, 675	5, 517, 079	525, 165	2, 192, 167	5, 196	2, 892	583
18	Tennessee	12	34	218, 254	89, 933	129, 951	14, 532	104, 465	147, 181	8, 679	83, 529	443	77	32
19	Texas	1	...	.....	.....	.....	3, 600	3, 600	8, 100	.....	.....	.....	.....	.....
20	Vermont	1	1	1, 120	560	2, 750	.....	560	2, 750	536	1, 500	8	7	.....
21	Virginia	9	26	1, 404, 524	169, 683	384, 331	12, 643	182, 326	439, 886	37, 783	186, 279	555	338	36
22	West Virginia	6	8	140, 520	60, 371	88, 595	845	61, 216	91, 057	5, 061	63, 985	114	150	2
23	Wisconsin	2	2	45, 600	41, 440	73, 000	.....	41, 440	73, 000	2, 250	17, 000	37	20	3

a Prepared for Census Bulletin No. 270. These figures have been cor

THE IRON-ORE STATISTICS.(a)

JOHNSON, JR.

ore, by states (condensed table).

Boys employed below ground.	Total number of employés in regular establishments.	Number of miners.	Number of laborers.	Number of administrative force.	Number of steam-engines.	Total horse-power.	Value of all machinery.	Cost of explosives used.	Number of horses used in regular industry.	Number of mules used in regular industry.	Amount used as working capital.	Value of plant.	Value of real estate.	Total capital employed and invested in the regular industry.	Number of tons on which royalty is paid.	Gross amount paid as royalty in census year.	
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
249	31, 668	17, 923	12, 492	1, 253	821	24, 838	$3, 211, 548	$484, 452	2, 680	1, 249	$4, 850, 763	$8, 657, 375	$48, 274, 149	$61, 782, 287	2, 334, 524	$1,020,429	
6	738	503	216	19	6	192	17, 765	4, 240	b 9	107	50, 900	46, 770	438, 772	536, 442	48, 610	5, 776	1
...	200	100	90	10	5	105	22, 225	3, 669	98	0	18, 500	39, 800	368, 000	426, 300	23, 677	42, 145	2
....	47	20	25	2	4	40	4, 400	3	6	16	2, 000	6, 300	40, 000	48, 300	.....	.....	3
...	342	217	105	20	0	0	1, 250	4, 200	0	68	35, 790	33, 935	101, 200	170, 925	.....	.....	4
....	325	224	88	13	0	0	0	1, 470	91	26	42, 000	59, 500	678, 329	779, 829	17, 986	3, 578	5
....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
....	20	12	8	.....	.....	.....	.....	2, 000	16	0	2, 000	2, 000	2, 500	6, 500	.....	.....	7
....	329	119	192	18	11	263	17, 164	789	37	45	44, 450	135, 464	310, 600	490, 514	11, 536	5, 387	8
....	382	216	156	10	8	220	34, 900	6, 818	50	2	22, 400	70, 600	183, 000	276, 000	3, 845	1, 227	9
17	5, 562	3, 163	2, 189	210	134	6, 574	838, 558	160, 561	390	37	2, 254, 520	2, 789, 944	12, 452, 311	17, 496, 775	392, 251	172, 145	10
10	1, 893	1, 126	690	77	17	448	131, 808	28, 972	67	241	254, 020	678, 313	4, 666, 223	5, 598, 556	140, 597	65, 144	11
69	4, 811	2, 931	1, 754	126	152	4, 486	519, 954	105, 130	70	48	562, 915	841, 226	4, 797, 620	6, 201, 761	364, 945	197, 691	12
35	4, 675	2, 269	2, 216	190	87	3, 039	634, 906	77, 093	323	48	537, 950	1, 281, 740	6, 443, 449	8, 263, 139	191, 415	73, 497	13
....	47	38	4	5	2	29	1, 850	72	0	2	1, 900	2, 750	8, 650	13, 300	.....	.....	14
....	14	11	2	1	1	16	1, 000	236	0	0	2, 225	5, 000	9, 750	16, 975	.....	.....	15
38	1, 716	1, 213	459	44	5	130	8, 600	7, 948	35	55	128, 179	263, 145	857, 401	1, 248, 725	50, 269	9, 004	16
62	8, 733	4, 717	3, 630	386	380	9, 117	934, 658	65, 288	1, 327	309	730, 064	2, 131, 743	14, 759, 894	17, 621, 701	972, 363	422, 067	17
....	552	419	109	24	.....	.....	.....	1, 209	22	84	27, 375	36, 095	410, 450	473, 920	48, 663	10, 569	18
....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
....	15	15	.....	.....	.....	.....	225	138	1	0	500	500	1, 000	2, 000	.....	.....	20
10	939	412	438	89	8	154	37, 785	13, 165	106	148	106, 625	206, 000	1, 496, 500	1, 809, 125	51, 044	11, 323	21
....	266	165	93	8	0	0	1, 500	1, 226	22	9	10, 450	16, 550	88, 500	115, 500	16, 823	1, 076	22
2	62	33	28	1	1	25	3, 000	225	10	4	16, 000	10, 000	160, 000	186, 000	.....	.....	23

rected where necessary to make them accord with the final results.

b 64 oxen are also reported in Alabama.

TABLE 17.—*Production of iron ore,*

	Name of state.	Product of largest mine.	Average product per mine.	Average number of hands to mine.	Average royalty paid per ton.	Average yearly income of man.	Average monthly net earnings of man.	Average number of tons raised per day per man.	Average per cent. of year employed in mining.	Per cent. of year not employed in mining.	Per cent. of year lost in strikes.	Average price per ton of ore at mine.
		1	2	3	4	5	6	7	8	9	10	11
		Tons.	*Tons.*		*Cents.*							
	The United States	280,000	8,772	39	43.70	$308 94	$33 20	0.96	77.55	22.43	0.02	$2 90
1	Alabama	23,364	10,830	43	11.83	171 67	24 70	1.43	57.91	42.09	.....	1 05
2	Connecticut	14,405	8,754	50	178.00	306 60	27 99	0.64	91.28	8.72	.....	4 22
3	Delaware	1,834	1,363	23	.....	69 04	31 80	1.06	18.09	81.91	.....	2 40
4	Georgia	44,225	10,386	49	.....	320 46	33 81	0.90	78.99	21.01	.....	1 57
5	Kentucky	17,435	6,704	65	19.89	221 82	27 18	0.50	68.02	30.78	1.20	2 56
6	Maine	6,000	6,000	20	.....	450 00	112 51	3.00	33.33	66.67	.....	1 50
7	Maryland	17,843	4,457	25	46.70	192 26	29 49	1.08	54.32	45.68	.....	3 02
8	Massachusetts	19,079	6,960	42	33.00	316 64	32 04	0.66	82.35	17.65	.....	3 61
9	Michigan	224,000	42,668	129	43.88	471 79	43 11	1.20	91.19	8.81	.....	3 28
10	Missouri	128,708	8,046	39	46.33	226 46	25 03	0.90	75.41	24.59	.....	4 33
11	New Jersey	85,622	6,925	44	54.17	339 59	39 84	0.74	71.03	28.18	0.79	3 84
12	New York	208,416	15,894	60	38.39	328 59	30 64	0.99	89.38	10.62	.....	2 89
13	North Carolina	1,686	364	5	.....	86 36	17 18	0.55	41.88	58.12	.....	1 59
14	Oregon	6,972	6,972	14	.....	157 86	25 06	3.16	52.50	47.50	.....	0 67
15	Ohio	9,381	6,628	57	17.90	196 79	25 98	0.61	63.13	36.15	0.72	2 31
16	Pennsylvania	280,000	5,085	24	43.38	260 65	28 57	0.91	76.04	23.80	0.16	2 52
17	Tennessee	13,608	2,645	16	21.71	155 84	23 23	0.97	55.91	44.09	.....	1 41
18	Vermont	560	560	15	.....	100 00	25 00	0.37	33.33	66.67	.....	4 91
19	Virginia	28,000	6,526	36	22.18	203 36	28 89	1.03	58.66	41.34	.....	2 41
20	West Virginia	29,120	7,546	33	6.40	241 45	28 81	1.08	69.84	29.79	0.37	1 48
21	Wisconsin	39,200	20,720	31	.....	285 71	35 71	3.34	66.67	33.33	.....	1 76

general average by states.

Cost of labor per ton of ore mined.	Cost of material per ton of ore mined.	Amount of interest, royalty, and profit per ton of ore.	Per cent. of value of product paid for labor.	Per cent. of value of product paid for material.	Per cent. of value of product left for royalty, profit, and interest.	Average horse-power of engines to mine.	Per cent. of miners to total force.	Per cent. of laborers in total force.	Per cent. of administrative force in total force.	Per cent. of capital in real estate.	Per cent. of capital in plant.	Per cent. of capital used for working capital.	Per cent. ratio of value of yearly product to total capital.	Per cent. ratio of tonnage produced to maximum capacity of production.	
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
$1 35	$0 41	$1 14	46.59	14.15	39.26	31	56.60	39.45	3.96	78.14	14.01	7.85	33.13	52.45	
67	10	27	65.22	9.32	25.46	11	68.16	29.27	2.57	81.80	8.70	9.49	28.00	59.37	1
1 75	60	1 87	41.38	14.10	44.52	26	50.00	45.00	5.00	86.32	9.30	4.34	34.71	76.46	2
1 05	35	1 00	43.72	14.36	41.92	20	42.55	53.20	4.26	82.82	13.04	4.14	13.78	14.82	3
1 50	11	07	90.14	6.91	2.95	.....	63.45	30.70	5.85	59.21	19.85	20.94	70.61	71.87	4
2 07	24	35	77.95	9.11	12.94	.....	68.92	27.08	4.00	86.98	7.63	5.39	11.40	31.80	5
1 50	52	*a* 52	100.00	35.00	(*a*)	.....	60.00	40.00	.....	38.46	30.77	30.77	72.20	50.00	6
1 06	41	57	51.79	20.10	28.11	20	36.17	58.36	5.47	63.32	27.62	9.06	24.07	39.88	7
1 87	68	1 06	51.81	19.07	29.12	24	56.54	40.84	2.62	66.30	25.58	8.12	81.93	71.70	8
1 40	51	1 38	42.65	15.60	41.75	153	56.87	39.36	3.77	71.16	15.94	12.89	34.49	82.52	9
1 08	27	2 98	24.02	6.27	68.81	9	59.48	36.45	4.07	83.34	12.11	4.54	30.00	39.90	10
2 13	77	94	55.38	20.14	24.48	41	60.92	36.46	2.62	77.36	13.56	9.08	46.77	50.74	11
1 22	43	1 17	43.08	15.27	41.65	39	48.53	47.40	4.06	77.98	15.51	6.51	42.34	57.60	12
1 24	29	03	79.56	18.91	1.53	3	80.85	8.51	10.64	65.04	20.67	14.28	38.36	27.35	13
32	09	26	47.33	12.85	39.82	16	78.57	14.28	7.14	57.44	29.46	13.11	27.51	31.13	14
1 66	12	47	73.60	5.31	21.09	4	70.69	26.75	2.56	68.66	21.07	10.26	35.88	35.75	15
1 20	29	88	50.76	12.16	37.08	25	54.01	41.57	4.42	83.76	12.10	4.14	24.51	53.41	16
93	10	41	64.27	6.68	29.05	.....	75.90	19.74	4.35	86.60	7.62	5.78	27.42	41.21	17
2 68	96	1 27	54.54	19.49	25.97	.....	100.00	.....	.....	50.00	25.00	25.00	137.50	50.00	18
1 10	22	95	48.47	9.83	41.70	6	43.88	46.65	9.48	82.72	11.39	5.89	21.24	12.08	19
1 06	08	33	72.22	5.72	22.06	.....	62.03	34.96	3.01	76.62	14.33	9.05	80.52	42.96	20
41	05	1 30	23.29	3.08	73.63	13	53.23	45.16	1.60	86.02	5.37	8.60	39.25	90.88	21

a Loss.

a

REMARKS ON TABLE 16.

Table 16 contains the principal results thus far compiled from the schedules of the production of iron ore during the census year ending June 1, 1880. The ton of 2,000 pounds is invariably used.

The second column of Table 16 gives the number of mines or establishments which have a regular industrial organization, and from whom it was possible to obtain an account of the capital, wages, and materials employed.

The sixth column, headed "irregular product", gives the amount of iron ore raised between the above dates by persons the principal part of whose livelihood was obtained in some other occupation, generally farming. In b twelve of the states there are localities where soft ore can be obtained from surface diggings. These are worked by farmers during the intervals of agricultural employment, the product drawn by farm teams to the nearest furnace and sold. The quantities of ore so preduced by individuals vary from 5 to 500 tons. In some instances, again, furnace companies own the land on which the ore is dug, and hire the farmers of the neighborhood to deliver it at the furnace for a fixed price per ton. This work is done in such an irregular and desultory manner that the only items safely attainable are the amount and value of the product, although the total so produced amounts to over a ninth (11.4 per cent.) of the entire tonnage of the country. An account of purchases of ore was obtained from the furnace companies in these localities, with the name of the producer, the price and technical name of the ore, and the name of the county where the ore was mined, or, more properly, dug. Great care has been taken to avoid duplication of any of the amounts so produced, by comparing the names taken from the books of the smelting establishments c with the names on the regular schedules of production received from our agents.

It will therefore be observed that no items based on this "irregular product" appear in the columns of employés, wages, materials, capital, etc.

The columns of production, both "regular" and "irregular", contain no estimates, but are made up from authentic returns.

A small amount of ore raised in Colorado is omitted, as it is used as a flux, and does not, as yet, affect the iron-manufacturing industry.

The total production, 7,974,806 tons, exceeds the amount reported as consumed in manufacturing establishments by Mr. Swank (7,709,706 tons) by 265,100 tons. There was imported during the census year at the ports of Buffalo, Boston, Oswego, Philadelphia, New York, and Baltimore 439,451 tons, from which it would appear that the stocks d of ore on hand must have increased during the census year about 704,551 tons, or that only 91.62 per cent. of the ore produced (and imported) was consumed during the period. In view of the fact that there was a scarcity of iron ore in 1879, and that many new mines were opened in consequence, whose stocks failed to reach consumers before the summer of 1880, the two results are easily reconcilable.

The value of the ore is taken at the mine, or at the point of the delivery to a customer or a transportation company, but always at the point where the expenses of labor and material, which come under our consideration, cease. Where the ore is smelted by the same company which mines it, it not unfrequently happens that the cost and value as returned are the same, since the ore is regarded as part of the furnace supplies. This has had the effect of depressing slightly the value returned to us below the market price, and of carrying part of the profits of mining into the manufacture of pig-iron.

e In nearly all of the iron-mining districts of the country, though the systems of labor vary, it is the custom that each miner or underground laborer furnish his oil or candle, and when working by the ton, his own powder and fuse. The amounts thus expended have, as far as possible, been deducted from the pay of the men and added to the cost of material, in order that the column headed "wages" might more nearly represent the net cash income of the laborer available for his support.

"Labor" is classified with regard to age and occupation. In the underground mines the classes of employés are well defined. In the open-cut and quarry mines the distinction between laborers and miners is more indefinite.

"Materials used" covers everything consumed in the business, including, among the more important items, feed for animals, timber, fuel, repairs of all kinds, tools, powder, fuse, lights, etc.

"Capital" is divided into—

f First, "working capital," or the sum of money required to run the mine from month to month and to pay wages and buy materials in producing the stock that is ordinarily carried. Taking the broad view of the entire industry, this portion of the capital is represented by marketable product and is not jeopardized.

Second, "plant," which represents the permanent openings, roads, buildings, machinery, etc., which are subject to rapid deterioration, require constant repairs, and are of little value when the mine is exhausted.

Third, "real estate," which means the land as a mineral producer, its value as such being considered apart from its possible value for agricultural or forestry purposes. This value is a fund which is constantly diminished as the ore is withdrawn, and eventually reaches zero; and must be made good by capitalizing the royalties. The lands in question are not wild lands, but such as are attached to a working mine. Their acreage cannot be given, as iron-ore deposits are irregular in their occurrence, but their extent is such that for all practical purposes their present annual yield may be regarded as not likely to be diminished for many years.

REMARKS ON TABLE 17.

a

Table 17 contains the averages drawn from the data in Table 16.

In finding the average net income of a man, the three classes of labor are considered together, and two boys are considered the equivalent of one man in earning capacity.

The year, which is divided in percentages of time lost and made, is the working year of twelve months of 25 working days each.

The small amount of time lost in strikes, equivalent to the average working lifetime of two men only, shows that no serious conflict between capital and labor arose during the census year in this industry. b

The low rate of monthly wages must be qualified by the consideration that the miner receives the advantages of low rent and prices of the necessaries of life, and in some cases privileges which cannot be brought into columns of statistics, but which tend to equalize his condition with the higher-paid labor of cities.

As stated before, the price of ore in some of the states, notably Georgia, North Carolina, Tennessee, Ohio, Virginia, and West Virginia, is seriously lowered by the fact that it is returned by furnace companies who, in many cases, include, in the price given, no allowance for royalty nor profit, as they charge it to their furnaces at cost. We have not felt at liberty to change the price fixed by a producer without positive information.

The product would replace the capital employed and invested in little more than three years, but the profits and royalty would require nearly seven and three-quarter years to effect the same result. It requires an investment of $8 75 on the average to produce a ton of ore yearly. c

The annual product, as will be observed, is but little in excess of one-half of the maximum capacity. The mines which yield ore fit for the manufacture of Bessemer steel, however, approach much nearer their greatest possible yield. "Maximum capacity" means an estimate of what could be produced from present developments, with present appliances, under the stimulus of a pressing demand. It could be attained with an increase of working capital and labor only. Its excess over real product is partly accounted for by the fact that many new mines went into operation during the latter part of the year.

The following table presents some comparisons with the census of 1870:

TABLE 18.

Changes in the iron-ore mining industry in the United States during the decade ending June 1, 1880, *expressed in percentages on the returns of the census of* 1870. d

	Per cent.	
Gain in number of establishments	91.67	
Gain in total number of employés	110.81	
Gain in total horse-power of steam-engines	189.69	
Gain in amount paid as wages	39.48	
Gain in amount paid for material	126.33	
Gain in total capital	247.61	
Loss in value per ton of product	25.45	
Gain in value of total product	75.45	
Gain in tonnage of total product	135.00	
Gain in product of regular establishments	108.00	
Loss in yearly income of man	32.13	e
Loss in per cent. of value of product paid for labor	5.19	
Gain in per cent. of value of product paid for materials	4.46	
Gain in per cent. of value of product retained for royalty, interest, profits, etc	0.74	

The gain in the total number of mine employés, 110.81 per cent., is slightly more than the gain, 108 per cent., in the product of the establishments to which they belong. This arises from the fact that many new mines were opened in 1879–'80, which were not productive till the latter part of the year. The effectiveness per man has undoubtedly been increased by the increased use of power, as shown in the large per cent., 189.68, and by the introduction of improved drilling machinery and high explosives. The census of 1870, unfortunately, affords no basis for making this important comparison. f

Proportionately more is expended for material and less for labor than was the case in 1870. This arises partly from the fact that wages are reduced to net wages, as explained before, and partly from a real increase in consumption of supplies as mining becomes more systematic and dependent on mechanical appliances.

The average yearly incomes of labor cannot be justly compared, for the same reason that we cannot compare its effectiveness, *i. e.*, because we cannot ascertain the proportion of the year lost in 1870.

The number of boys employed has increased at a much more rapid rate than the number of men. They now constitute 5 per cent. of the entire force, and have increased 348 per cent. in ten years.

The large gain in capital, 247.61 per cent., is explained by the fact that all iron-ore producing property was included in the present census, whether it belonged to the mine operator or was leased or worked on a royalty. Viewing the iron lands returned as a whole, they are capable of keeping up the present annual yield for na

a indefinite time, though parts of them may become rapidly exhausted. Extending the average royalty of 42 cents a ton to the entire product, we would have a yearly income of over three millions of dollars, or rather more than 6.25 per cent. on the returned value of the real estate. In view of the fact that this income, though not likely to be diminished for fifty years to come, is very far from being a perpetual annuity, it will be seen that the present value of the real estate is not overestimated.

After taking out the royalty charge, if from the remainder of the annual net receipts we deduct an amount equal to 6 per cent. interest on the working capital, there is left, in round numbers, the sum of $4,690,000. The "plant", consisting of animals, boilers, engines, tools, buildings, cars, tracks, etc., is subject to a deterioration of not far from 30 per cent. yearly. Deducting this, leaves $2,096,000 as the profits and expenses of the general b management of the business, or a trifle over 9 per cent. of the value of the annual product, a proportion which cannot be called excessive; for it must be remembered that, though the income of the business, *as a whole*, is a steady and regular addition to our national wealth, each individual mine is subject to interruptions from accidents, and to exhaustion of the mineral deposit. Consequently, the net income of each individual mine cannot be regarded as consisting solely of interest, royalty, and profits, but must be charged, for safety, with a certain sum for insurance against unforeseen contingencies, which would not be necessary if one company owned the entire property.

The conditions of iron-ore mining are so different in different districts that only the most general analysis can be applied to the totals. The above considerations show that the general relations between capital and production spread over our returns are harmonious, and are given, not so much with a view to prove the healthy condition of the industry, as to justify the assertion that our valuations of capital are very far from extravagant, though the c period during which they were made—the summer of 1880—was one of great activity in iron mining.

It may be observed, too, that the real estate which furnishes the "irregular product" of 909,977 tons is far from worthless as mineral land, though we have not included it in our valuation. Its principal value, however, consists in the fact that it affords its owners a field for moderately remunerative labor.

The average price per ton has fallen from $3 89 to $2 90, or 25.45 per cent. As gold averaged about 30 per cent. above the the paper dollar in 1870, the true fall in iron ore is only 14 cents a ton.

Since the last census was taken the average price per ton has changed in the five great states as follows: In Michigan it has fallen 15 per cent.; in Missouri it has risen 56.32 per cent.; in New Jersey it has fallen 30 per cent.; in New York it has fallen 29 per cent.; in Pennsylvania it has fallen 35 per cent. These irregularities are chiefly due to the increased demand for ores suitable to the manufacture of Bessemer steel.

d

TABLE 19.—*List of iron-ore producing states in order of the production of* 1880.

	States.	Total product.	Per cent. of total product.	Per cent. of total value of product.		States.	Total product.	Per cent. of total product.	Per cent. of total value of product.
		Tons.					*Tons.*		
1	Pennsylvania	2,185,675	27.407	23.817	13	Massachusetts	62,637	0.785	0.977
2	Michigan	1,837,712	23.044	26.051	14	West Virginia	61,216	0.767	0.394
3	New York	1,262,127	15.827	15.776	15	Wisconsin	41,440	0.519	0.316
4	New Jersey	757,372	9.497	12.594	16	Connecticut	35,018	0.439	0.638
5	Ohio	547,403	6.864	5.480	17	Oregon	6,972	0.087	0.020
e									
6	Missouri	386,197	4.843	7.230	18	Maine	6,000	0.075	0.039
7	Alabama	191,676	2.404	0.872	19	Texas	3,600	0.046	0.035
8	Virginia	182,326	2.286	1.899	20	North Carolina	3,318	0.041	0.023
9	Maryland	139,628	1.751	1.820	21	Delaware	2,726	0.034	0.028
10	Tennessee	104,465	1.310	0.638	22	Vermont	560	0.007	0.012
11	Georgia	91,416	1.147	0.621	23	Indiana	513	0.007	0.004
12	Kentucky	64,809	0.813	0.716		The United States	7,971,706		

TABLE 20.

f The rank of the 16 states reported in the census of 1870, as producers of iron ore, was as follows:

1. Pennsylvania.
2. Michigan.
3. New York.
4. New Jersey.
5. Ohio.
6. Missouri.
7. Maryland.
8. Tennessee.
9. Massachusetts.
10. Wisconsin.
11. Kentucky.
12. Virginia.
13. Vermont.
14. North Carolina.
15. Delaware.
16. Indiana.

The 6 great iron states retain in 1880 their former relative rank, and Alabama, a new state, takes the rank next them. Pennsylvania and Michigan yield over one-half the entire product. The 6 states at the head of the list yield 87.48 per cent. of the total, which is worth 90.94 per cent. of the total value. Sixteen states were reported in 1870 against 23 at present. The new iron-producing states are Alabama, Georgia, West Virginia, Connecticut, Oregon, Maine, and Texas. They produce 4.96 per cent. of the product. Virginia has gained four places; Maryland and Tennessee have lost two, Massachusetts four, and Kentucky one.

TABLE 21.—*List of counties of the first class producing over* 100,000 *tons.*

	County.	State.	Tons.		County.	State.	Tons.
1	Marquette	Michigan	1,346,365	8	Blair	Pennsylvania	154,914
2	Essex	New York	631,807	9	Saint François	Missouri	144,265
3	Morris	New Jersey	568,420	10	Lawrence	Ohio	136,464
4	Menominee	Michigan	491,347	11	Dutchess	New York	126,654
5	Lehigh	Pennsylvania	419,700	12	Northampton	Pennsylvania	122,526
6	Berks	do	304,954		Total of 12 counties of the 1st class.		4,869,510
7	Lebanon	do	285,629				

The 12 counties above produced 61.06 per cent. of the entire tonnage, of which total Marquette county, Michigan, must be credited with 16.88 per cent.

Menominee county, Michigan, is the only one of the above which did not produce iron ore in 1870. The total number of counties from which reports have been received and tabulated is 135, against 71 in 1870, a gain of a little over 90 per cent.

TABLE 22.—*List of counties of the second class producing less than* 100,000 *tons and over* 50,000 *tons.*

	County.	State.	Tons.		County.	State.	Tons.
13	Clinton	New York	92,166	21	York	Pennsylvania	70,058
14	Orange	do	90,742	22	Jefferson	New York	64,111
15	Crawford	Missouri	87,033	23	Berkshire	Massachusetts	62,637
16	Putnam	New York	94,117	24	Dent	Missouri	58,878
17	Sussex	New Jersey	89,665	25	Iron	do	57,297
18	Lancaster	Pennsylvania	78,850	26	Warren	New Jersey	50,214
19	Fayette	do	76,140		Total of the 14 counties of the 2d class.		1,056,823
20	Cumberland	do	75,915				

The above 14 counties, in 5 states, produce 13.25 per cent. of the entire product. The 26 leading counties produce 74.31 per cent. of the entire product, leaving 25.69 per cent. to be spread over the remaining 109 counties.

The following table contains a list of all mines or industrial establishments producing over 50,000 tons during the census year, in the order of their production:

TABLE 23.

State.	County.	Name of mine.	Product.	Value of product.	Employés.
			Tons.		
Pennsylvania	Lebanon	Cornwall Ore Bank	280,000	$500,000	135
Michigan	Marquette	Republic	224,000	896,000	600
Do	do	Lake Superior Iron Company	215,930	771,180	542
Do	Menominee	Norway & Cyclops	210,875	527,187	510
New York	Essex	Old Bed	208,416	744,344	321
Do	do	Mine 21	187,448	238,525	282
Missouri	Saint François	Iron Mountain	144,153	1,061,801	300
Michigan	Marquette	Jackson	134,585	569,582	252
Do	do	Cleveland Iron Mining Company	125,440	448,000	450
New York	Essex	Crown Point	112,000	500,000	450
Michigan	Marquette	Champion	99,609	355,748	350
New Jersey	Morris	Glendon Hibernia	85,623	382,245	550
Michigan	Menominee	Vulcan	83,394	208,485	200
Do	Marquette	Michigamme	66,158	212,652	197
Do	Menominee	Quinnesec	63,689	159,220	178
Missouri	Crawford	Merimec Iron Mining Company	60,385	134,788	184
New York	Putnam	Tilly Foster Iron Mines	56,000	131,500	250
Missouri	Iron	Pilot Knob	52,761	115,993	410
New Jersey	Morris	Mount Hope	50,379	264,390	194
Total			2,460,845	8,222,640	6,355

The preceding 19 mines yielded 34.85 per cent. of the entire tonnage of the "regular mines", the value of which reached 40.16 per cent. of the value of the total. The labor employed by them, however, aggregates only 20.06 per cent. of the entire force, as it is generally worked more continuously and at higher wages.

The product of the Cornwall Ore Bank was 3.97 per cent. and of the Republic 3.17 per cent. of the entire product of the regular mines.

One hundred and seventy-four mines have been opened during the census year, or 21.6 per cent. of the total reported.

During the census year the iron-mining industry consumed 6,907,931 linear feet of round timber for props, etc., valued at $114,951; 8,625,463 superficial feet of sawed lumber, valued at $128,110; and 88,443 cords of wood for fuel, valued at $177,309; all of which is included in the gross amount of materials used.

NOTES

ON THE

SAMPLES OF IRON ORE COLLECTED FOR ANALYSIS

AND

ON THE ORE DEPOSITS FROM WHICH THEY WERE TAKEN.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN NORTHERN NEW ENGLAND.

By Edward R. Benton.

MAINE.

676,677,678. *Katahdin*, Piscataquis county. Limonite. One mile west of Katahdin iron-works, the works being about 50 miles north-northwest of Bangor and 19 miles north-northwest of Milo station, on the Bangor and Piscataquis railroad.

Mining was carried on here many years ago, but until 1873 only the ore occurring immediately on the surface (*i. e.*, not over 2 feet deep) was used. Since that time, when the works came under the management of O. W. Davis, jr., ore occurring 5 to 15 feet below the surface has been used.

The present workings consist of three excavations on the north side of a hill 1 mile west of the Katahdin iron-works. These excavations are 5 to 15 feet deep, and all show about the same character of deposit. Between the nearly east and west line connecting these excavations, and a road which runs 350 to 400 feet to the north of them, the ground has been to a great extent stripped of the overlying glacial drift, disclosing ore over an extent of 12 to 13 acres.

The excavations show several feet of glacial drift above, and below that irregularly alternating layers of two kinds of iron-bearing material, one the ore proper (hand-specimens 677, 677*a*, and 677*b*), the other a dark gray or bronze-colored material, consisting largely of sulphide of iron, and having a decomposed appearance (hand-specimens 677*c* and 677*d*). According to Mr. Colby, the chemist of the iron-works, the latter material contains 30 per cent. of sulphur. Piled in heaps it oxidizes rapidly, giving off sulphurous fumes, and depositing in the crevices fine crystals of sulphur and of sulphate of iron.

The layers of this material and of the ore are, in the main, conformable with the surface of the ground. The ore proper is a porous to cavernous limonite, showing mamillary, stalactite, and lamellar forms. It is said to contain before roasting about 4 per cent. of sulphur, but after being roasted in a Westmann kiln only 0.06 per cent.

The "surface" ore is limonite, and has in some places a basis of leaves and twigs, while in others it fills the interstices in the glacial gravel (hand-specimen 678).

The mine and furnace are managed by O. W. Davis, jr., and the ore is all used in the company's furnace.

677. Analysis: Iron, 46.00. Phosphorus, 0.009. Sulphur, 3.004. Phosphorus in 100 parts iron, 0.019. Sample taken from pile of raw ore at the furnace and from piles of ore ready for the furnace at the three excavations, 1 mile west of the furnace.

676. Analysis: Iron, 57.20. Phosphorus, 0.012. Phosphorus in 100 parts iron, 0.021. Sample taken from piles of roasted ore at the furnace.

678. Analysis: Iron, 47.28. Phosphorus, 0.037. Phosphorus in 100 parts iron, 0.078. Sample of "surface" ore taken near the three excavations, 1 mile west of the furnace.

Following is the complete analysis of No. 677:

	Per cent.		Per cent.
Sulphur	3.004	Potassa	0.12
Phosphorus	0.009	Soda	0.28
Iron, metallic	46.00	Carbonic acid	0.08
		Sulphuric acid	3.05
Silica	8.50	Phosphoric acid	0.020
Iron, protoxide	3.32	Titanic acid	.....
Iron, peroxide	59.95	Carbon in carbonaceous matter	0.27
Alumina	2.08	Hygroscopic water	3.86
Manganese, protoxide	0.02	Water of composition	11.46
Manganese, dioxide	.....	Total	100.120
Chromium, sesquioxide	0.19		
Lime	1.50	Per cent. of insoluble silicious matter	12.69
Magnesia	1.96	Silica	8.50
Iron, disulphide	9.270	Alumina	2.15
Zinc, sulphide	.....	Lime	0.58
Nickel, sulphide	0.13	Magnesia	1.51
Cobalt, sulphide	.....		
Copper, sulphide	0.06	Total	12.74

NEW HAMPSHIRE.

a

679. *Franconia*, Grafton county. Magnetite. Three miles southwest of Fraconia furnace, which is at Franconia village, 5 miles south of Littleton.

This mine and furnace have been in operation at various times since 1814. They were last operated in 1865. The deposit consists of a seam of magnetic ore imbedded in a chloritic schistose rock, and standing nearly vertical. The deposit occurs on the southwest side of a hill, and extends in a nearly northeast and southwest direction. The ore has been removed for a length of about 1,000 feet, and to a depth of at least 40 to 50 feet. Its thickness varies from 5 to 20 feet. The mine was inaccessible, so that the greatest depth reached could not be ascertained.

b More recent workings consist of a shaft at the southwest end of the old part of the mine. This shaft was said by Mr. Edson, who formerly had charge of the mine, to be 140 feet deep; it was long since abandoned. The furnace and mine are owned by Mr. Coffin, of Boston, Massachusetts.

679. Analysis: Iron, 49.01. Phosphorus, 0.188. Phosphorus in 100 parts iron, 0.384. Sample taken from piles of ore at the mine, and also from ore-piles at Franconia furnace.

VERMONT.

680. *Monkton*, Addison county. Limonite. One mile north of Caleb Rockwood's house, in Monkton.

c Not worked in the last twenty-five years. Nothing is to be seen of old workings except a pit filled with water, two piles of roasted ore covered with grass, and a few pieces of weathered ore lying about. The pit is about 250 feet long and 75 feet wide; depth unknown. It extends about east and west.

The ore was used about thirty years ago in a forge near Bristol, Vermont. It was mixed with ore from the west side of Lake Champlain.

680. Analysis: Iron, 42.05. Phosphorus, 0.223. Manganese, 0.65. Phosphorus in 100 parts iron, 0.530. Sample taken from a few pieces of weathered ore lying near the old excavation.

681. *Forestdale* or *Blake*. Rutland county. Limonite and hematite, manganiferous. Two miles east of Brandon village, at the Ocher works.

At this locality an iron mine was operated at least fifty years ago. No mining for iron has been done here for d many years, except for a short time two years ago. Several very old ore-pits are to be seen, and a more recent pit, 200 feet long and 60 feet wide, and filled with water. This pit, like all the more recent ones in the region, has been worked chiefly for ocher and umber for mineral paint. A little limonite (lump) is continually found, and raised with the ocher. Glacial drift is from 10 to 50 feet thick in this region.

The mine is operated to supply the ocher works of the Brandon Kaolin and Paint Company, of Brandon.

681. Analysis: Iron, 51.48. Phosphorus, 0.237. Phosphorus in 100 parts iron, 0.460. Sample taken from piles of several hundred tons of lump ore at the Brandon ocher-works.

682. *Brandon*, Rutland county. Limonite, manganiferous. Two miles northeast of Brandon village, near the ocher-works (not the works mentioned in connection with 681), and about a quarter of a mile north of the Forestdale or Blake mine.

e Many old shafts and pits are to be seen, but none are now operated for iron ore. These old shafts and pits extend north and south along the valley for half a mile, and over a width of several hundred feet; in most of them some iron ore was found. The shafts now working are operated for ocher, umber, and kaolin, but occasional bunches of iron ore are found and raised with the other material. Mr. Orum has charge of these ocher-works.

682. Analysis: Iron, 42.05. Phosphorus, 0.106. Manganese, 0.08. Phosphorus in 100 parts iron, 0.252. Sample taken from piles of lump-ore along roadside, taken from the ocher-shafts from time to time.

683. *Leicester*, Addison county. Limonite. Just north of Leicester ocher-works, and just east of Little or Hitchcock's pond, in the southern part of Leicester.

This mine consists of a large pit, about 30 feet deep, from which the ocher and umber are taken. A little f manganiferous limonite is found with it. The beds dip very slightly to the northwest. Mr. Brownson has charge of these works.

683. Analysis: Iron, 47.00. Phosphorus, 0.223. Manganese, 5.33. Phosphorus in 100 parts iron, 0.474. Sample taken from small piles of ore at the ocher-works which came from the pit described above.

684. *Granger* or *Pittsford*, Rutland county. Limonite. Close to Granger or Pittsford furnace (mouth of), eastern part of Pittsford.

Dilapidated pit and shaft from which the furnace was formerly supplied. Self-fluxing magnetite from Chateaugay, New York, is now exclusively used. Mr. Pritchard, furnace-manager.

684. Analysis: Iron, 45.80. Phosphorus, 0.268. Phosphorus in 100 parts iron, 0.585. Sample taken from small piles of greatly-weathered ore at old shaft just north of furnace.

685. *Godfrey*, Bennington county. Limonite. Two miles east of Bennington village on the railroad, close to the eastern boundary of the town.

Two dilapidated shafts; depth unknown; no ore in place to be seen. Worked for iron four years ago. Owned by Burden, Troy, New York.

685. Analysis: Iron, 45.90. Phosphorus, 0.614. Phosphorus in 100 parts iron, 1.338. Samples taken from piles of ore at dilapidated washing-machine near shafts.

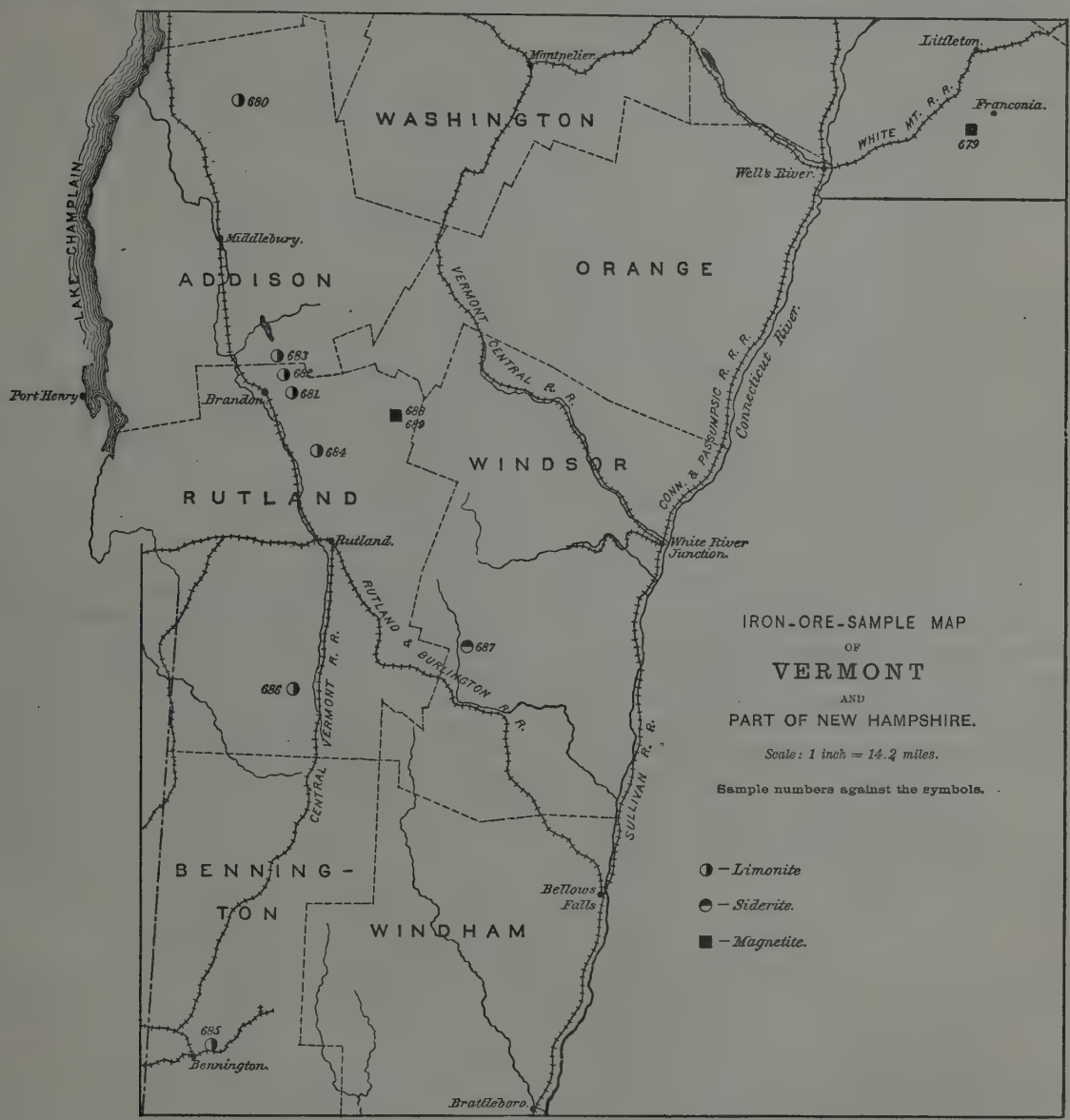


FIG. 8.

686. *Chipman*, Rutland county. Limonite. Seven hundred to 800 feet east of Bartlett Stafford's house, at the north end of Tinmouth pond, in the southeast part of Tinmouth.

A large number of old pits, but no ore in place to be seen. Ore formerly used in a furnace at Dorset, Vermont.

686. Analysis: Iron, 42.90. Phosphorus, 0.174. Phosphorus, in 100 parts iron, 0.406. Sample of weathered ore at old pits.

687. *Tyson furnace*, Windsor county. Siderite. On Mr. Davis's land, 1½ miles northeast of Tyson furnace, in the southeast part of Plymouth.

This ore occurs in the form of a seam in mica and chlorite schist. Its strike, like that of the foliation of the schists, is north 25° east. The dip is 50° to 70° east. The thickness is 6 to 10 feet, and the gangue is chlorite, biotite, quartz, and garnet.

a The workings consist of an open cut, perpendicular to the strike, to reach the seam, and then a cut along the seam both ways, the length of the latter cut being 75 feet and the depth 25 to 30 feet. The ore and gangue contain pyrite and chalcopyrite, and the iron formerly made from it in Tyson furnace is said to have been too brittle for use.

687. Analysis: Iron, 32.24. Phosphorus, 0.010. Phosphorus in 100 parts iron, 0.031. Sample taken from ore-piles at Tyson furnace and at the mine.

Following is the complete analysis of No. 687:

	Natural ore.		Natural ore.
	Per cent.		*Per cent.*
Sulphur	2.158	Sulphuric acid	0.15
Phosphorus	0.010	Phosphoric acid	0.023
Iron, metallic	32.24	Titanic acid	.....
		Carbon in carbonaceous matter	0.22
Silica	11.31	Hygroscopic water	0.08
Iron, protoxide	40.19	Water of composition	0.34
Iron, peroxide	.....	Total	100.09
Alumina	3.74		
Manganese, protoxide	2.56	Per cent. of insoluble silicious matter	13.28
Manganese, dioxide	.....	Silica	11.31
Lime	1.74	Alumina	1.37*a*
Magnesia	7.26	Lime	0.34
Iron, disulphide	3.747	Magnesia	0.10
Zinc, sulphide	Trace.	Potassa	0.06
Nickel, sulphide	0.24	Soda	0.16
Cobalt, sulphide	Trace.	Phosphoric acid	Trace.
Copper, sulphide	0.20	Titanic acid	.....
Potassa	.....	Total	13.34
Soda	.....		
Carbonic acid	28.29		

a With trace of oxide of iron.

688, 689. *Bethel* or *Pittsfield*, Rutland county. Magnetite. Two and a half miles west of Pittsfield village.

d The ore-bearing material at this locality is a ledge of metamorphic rock composed chiefly of quartz with some mica, and pervaded throughout with small crystals of magnetite. The rock is crushed and washed by steam-dressing machinery, and the crystals of magnetite readily separated.

No iron had been made from this ore, but near Bethel iron has been made from the magnetic sand of White river, which was probably derived from the same rock formation as that now worked at Pittsfield. Near the dressing-works forges for the making of steel by a patent process have already been begun.

688. Analysis: Iron, 10.10. Phosphorus, 0.146. Phosphorus in 100 parts iron, 1.446. Sample of rock from ledge at the dressing-works. Untreated.

689. Analysis: Iron, 65.82. Phosphorus, 0.026. Phosphorus in 100 parts iron, 0.040. Sample of magnetic grains, from the rock of the ledge at the dressing-works. Crushed and washed, ready for smelting.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN CONNECTICUT AND MASSACHUSETTS.

By Bayard T. Putnam.

CONNECTICUT.

Magnetic ore occurs at several localities in the state,(*a*) but it has nowhere been found in sufficiently large quantities to pay for mining. Specular hematite is almost unknown. Spathic ore exists near Roxbury, Roxbury township, Litchfield county, and was mined in the early part of the last century. The mine was described by Mr. Shepard (*b*) in 1837, and at a later date a furnace was built at Roxbury to use the ore. But for several years past both mine and furnace have been idle. Limonite is at present the only ore of iron mined in Connecticut. The deposits now worked are in Kent and Salisbury townships, Litchfield county. In former years bog-ore was dug in the southeastern part of the state, but these beds have long since been abandoned. The beds of limonite have in general the same characteristics as those in Dutchess and Columbia counties, New York.

c

The *Kent* (17) (*c*) mine is located in Kent township, about 2 miles north of east from South Kent post-office. It is owned and worked by the Kent Iron Company, and the ore is all used in the company's furnace. Although an old mine (it was described by Mr. Shepard), it has not in recent years been extensively wrought, and previous to March, 1880, it had been idle for four years. No ore was raised in the census year. The ore lies between a decomposed micaceous gneiss on the west and a bluff of quartz rock on the east. The associated clay and ocher are similar in appearance to those usually found with the limonite. The workings are now all underground. There is one shaft 75 feet deep, and the ore is being exploited from four levels. Considerable rock-ore is obtained. Samples from piles of 100 tons of rock-ore and 300 tons of washed ore contained—

d

e

f

	No. 773.	No. 774.
	Per cent.	*Per cent.*
Metallic iron	53.02	50.48
Phosphorus	0.315	0.353
Phosphorus in 100 parts iron	0.594	0.699

Sample No. 773 is the rock-ore; sample No. 774 is the washed ore.

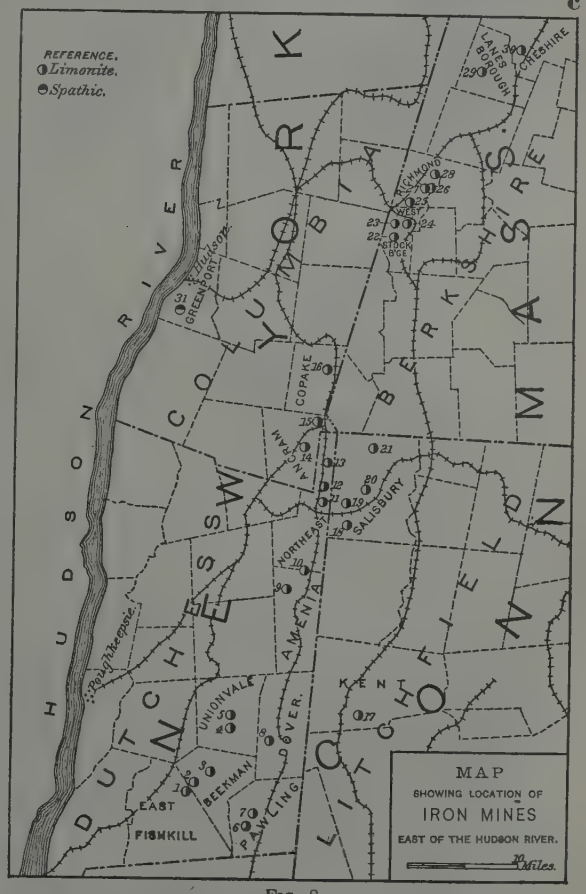


Fig. 8.

a See *Report on Geological Survey of Connecticut*, by C. U. Shepard, M. D., New Haven, 1837, p. 145.

b *Loc. cit.*, p. 30.

c The numbers refer to the map, Fig 8.

a Occurring in the ore-bed are masses or "horses" of an iron breccia, consisting of irregular angular pieces of limonite and quartz cemented together with limonite. Although usually too lean to be considered an ore of iron, a sample of it was collected and contained—

	No. 772.
	Per cent.
Metallic iron	30.82
Phosphorus	0.196
Phosphorus in 100 parts iron	0.636

b The *Chatfield* mine (18) near Ore Hill, Salisbury township, was opened in 1740. From 1868 to 1880 the mine produced 168,000 tons of ore. In the census year 11,200 tons were raised. The mine is worked by the Chatfield Mining Company. The ore is used in the neighboring charcoal furnaces. The pit is about 120 feet deep, and in some places the ore is covered with 60 feet of "stripping". Underground mining was begun on the north side of the pit in April, 1880. The workings are on three tracts of land (Fig. 9), and the ore from each tract is washed separately. A good opportunity was therefore presented to obtain samples from different parts of the same bed of ore. The samples collected **c** contained—

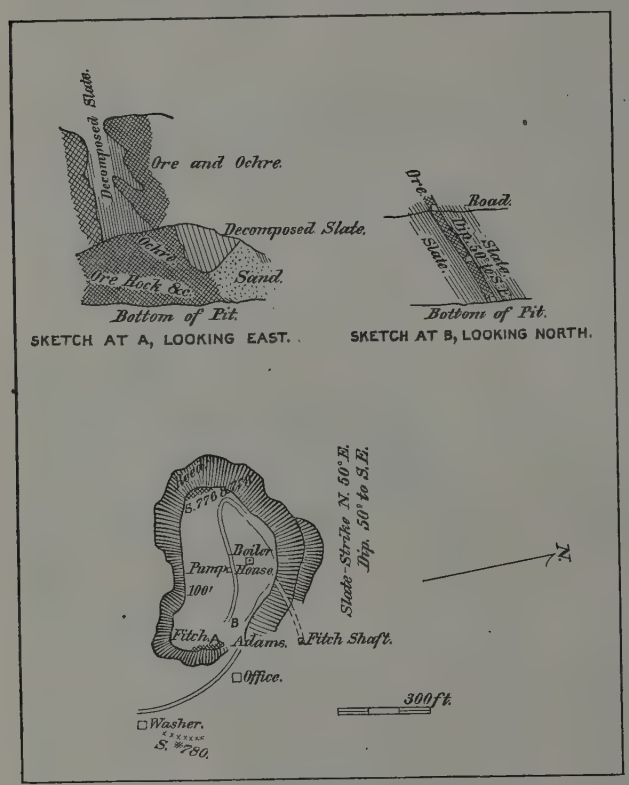


FIG. 9.—SKETCH OF THE CHATFIELD MINE, LITCHFIELD COUNTY.

NOTE.—The area represented by the "sketch at A" is about 10 by 10 feet. In the "sketch at B", the vertical distance between the road and the bottom of the pit is about 75 feet.

	No. 775.	No. 776.	No. 777.	No. 778. (*a*)	No. 779.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Metallic iron	35.10	40.03	44.04	44.38	48.02
Phosphorus	0.128	0.113	0.100	0.103	0.120
Phosphorus in 100 parts iron	0.364	0.282	0.227	0.232	0.250

a Contains manganese and baryta.

d Sample No. 775 is from 30 tons washed ore from bottom of tunnel, Adams' tract; sample No. 776 is from 40 tons washed ore from Reed's tract (west end of pit); sample No. 777 is from 45 tons washed ore from upper tunnel, Fitch's tract; sample No. 778 is from a few tons rock-ore from Reed's tract; sample No. 779 is from a few tons rock-ore from Fitch's tract.

The ore is washed in a Bradford washer. A sample of the "slacks" was collected along the slack-stream from a point about 75 feet from the washer to **e** the washer. The sample contained—

	No. 780.
	Per cent.
Metallic iron	15.96
Phosphorus	0.071
Phosphorus in 100 parts iron	0.445

Where entered by the tunnels the ore lies in a narrow seam conformably between layers of partially decomposed slate. A noticeable movement or "fault" in the ore mass at the east end of the pit is indicated in the **f** "sketch at A".

The *Brookpit* or *Ore Hill* mine (19) is northwest of the Chatfield. The Connecticut Western railroad crosses one of the old pits. The mine was opened in 1731; in the census year 14,405 tons of ore were produced; the mine is worked by the Brookpit Mining Company. Ore Hill is completely covered with excavations, but when visited only one pit—called the New Pit—was being worked. No underground mining has been attempted, although the ore is covered with 30 to 40 feet of decomposed slate, clay, and gravel. The ore appears to be interbedded in the slate, as is shown in Fig. 10. Immediately above the ore the slate is so much decomposed as to require but little if any blasting, while still higher up the change into clay is complete. Many beautiful specimens of crystallized limonite have been found in this deposit. Samples consisting of selected chippings of two varieties of crystallized ore yielded on analysis—

a

	No. 781.	No. 782.
	Per cent.	*Per cent.*
Metallic iron	55.37	57.00
Phosphorus	0.101	0.452
Phosphorus in 100 parts iron	0.182	0.793

Sample No. 781 represents a comparatively solid ore which has a fibrous structure and a silky luster. One surface of the specimen is jet black and is highly polished. The fibers are normal to this polished surface. Sample No. 782 consists of selected pieces of small stalactites. A transverse section of a stalactite shows it to have a radiated fibrous structure. The outer surface is smooth and highly polished. The stalactites are found in geodes or bombs and usually hang vertically. The great difference in the per cent. of phosphorus in the samples is noticeable. The samples were taken near each other in the deposit, and the two varieties appear to have been formed in the same manner, *i. e.*, through the solution of the iron oxide in surface-waters and recrystallization.

b

About one-half of the ore mined is rock-ore, and is shipped without treatment. Of the wash-ore one-half to one-third is lost in washing. Sample No. 783 is from 5 car-loads of rock-ore, and sample No. 784 is from 3 car-loads of washed ore. These samples contained—

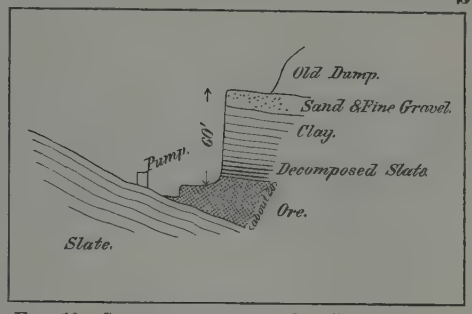


FIG. 10.—SKETCH SECTION AT ORE HILL, LITCHFIELD COUNTY, CONNECTICUT.

c

	No. 783.	No. 784.
	Per cent.	*Per cent.*
Metallic iron	50.12	44.80
Phosphorus	0.196	0.162
Phosphorus in 100 parts iron	0.393	0.362

Following is the complete analysis of No. 783:

d

	Natural ore.		Natural ore.
	Per cent.		*Per cent.*
Sulphur	0.150	Phosphoric acid	0.450
Phosphorus	0.196	Carbon in carbonaceous matter	0.06
Iron, metallic	50.12	Hygroscopic water	0.81
		Water of composition	10.67
Silica	9.84	Total	100.029
Iron, protoxide	0.25		
Iron, peroxide	69.46	Per cent. of insoluble silicious matter	12.69
Alumina	3.65		
Manganese, protoxide	1.27		
Lime	1.12	Silica	9.84
Magnesia	0.86	Alumina (with trace of oxide of iron)	2.01
Iron, disulphide	0.279	Lime	0.14
Potassa	0.69	Magnesia	0.29
Soda	0.44	Potassa	0.41
Carbonic acid	0.14	Total	12.69
Sulphuric acid	0.04		

e

The *Porter* mine, at Lakeville, was not worked in the census year.

The *Davis* or *Forbes* mine (20), north of Lakeville, is owned by the Forbes Ore-Bed Company, and is operated by the Davis Digging Company. Ore was first dug here in 1732, the year after the opening of the Brookpit bed. f In the census year 9,272 tons of ore were mined. Since 1867 the average annual yield has been about 9,000 tons. The ore is used by Barnum, Richardson & Co., the Lime Rock Iron Company, and the Hunts-Lyman Iron Company. Besides the ordinary limonite there occurs in this bed a manganiferous ore, and occasionally, also, pockets of black, earthy manganese. Samples taken of each variety yielded on analysis—

	No. 786.	No. 787.	No. 788.	No. 785.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	27.46	2.24	41.55	44.59
Metallic manganese	26.60	25.81	.....	.....
Phosphorus	0.045	0.068	0.073	0.059
Phosphorus in 100 parts iron	0.164	.....	0.176	0.132

a Sample No. 786 is from 15 tons of washed manganiferous ore; it is darker in color than the ordinary limonite, but in other respects resembles it. Sample No. 787 is from a pocket of black, earthy manganese in the pit. Sample No. 788 is from a few tons of the ordinary rock-ore, and sample No. 785 is from 20 tons of the ordinary washed ore.

The *Chapin* mine (21), 2 miles west of Chapinville, in the northern part of Salisbury township, and on lands of J. and N. E. Scoville, was opened some 80 years ago, and the ore was used to supply the old Chapin forge. The mine was reopened in December, 1879, and 140 tons of ore were raised in the census year. The pit is about 50 feet deep, and is entered by an adit 600 feet long. The ore lies between limestone and slate. A sample taken from 50 tons of rock-ore contained—

b

	No. 789.
	Per cent.
Metallic iron	54.47
Phosphorus	1.000
Phosphorus in 100 parts iron	1.836

The ore is very compact and heavy; its high contents in phosphorus is noticeable.

There are several other localities in Salisbury township where ore has been dug, but the foregoing are the only ones that have been worked for a number of years. The Indian Pond mine, too, in Sharon township, at one time supplied a large amount of ore, but it is now idle.

c

MASSACHUSETTS.

In Massachusetts, as in Connecticut, magnetic and specular ores have been found in small quantities only and are not commercially important. Carbonate of iron occurs associated with the limonite, and bog-ore is abundant in the central part of the state. But the only ore now mined is the limonite of Berkshire county. The occurrence of this ore here is similar to its occurrence in Connecticut and New York. It was formerly exploited in open pits, but during the past few years underground mining has been very generally resorted to.

The *Chauncey Leet* mine (22), owned and worked by the Hudson Iron Company, is located about 1¼ miles west of the village of West Stockbridge. It was opened in 1852, and it is estimated has produced a total of 504,000 tons of ore. In the census year 19,079 tons were raised. The ore is used at Hudson. The workings are entirely under-
d ground. There are two working shafts, and the lowest level is about 100 feet below the bottom of the old pit, or 140 feet below the original grass-line. The length of the workings is between 700 and 800 feet. Nearly the whole of the ore is washed. A sample from five car-loads contained—

	No. 790.
	Per cent.
Metallic iron	47.52
Phosphorus	0.187
Phosphorus in 100 parts iron	0.394

The *Nathaniel Leet* mine (23), owned by the Stockbridge Iron Company and worked by the Richmond Iron
e Company, is north of the Chauncey Leet. Ore was dug here before the Revolution. From January 1, 1870, to June 1, 1877, 81,715 tons of ore were mined. The shipments in the census year were 9,210 tons. The ore is used at Richmond, Van Deusenville, and Cheshire. The mine is worked both open-cut and underground. A sample from 50 tons of washed ore contained—

	No. 793.
	Per cent.
Metallic iron	46.65
Phosphorus	0.174
Phosphorus in 100 parts iron	0.373

f The *Goodrich* mine (24) lies east of the Nathaniel Leet mine. It was opened in 1875 and reopened in September, 1879. It is now worked by Lawrence Moffatt. The ore is used in the Pomeroy iron-works. In the census year 2,197 tons of ore were produced. The mine is worked entirely undergronnd. There is one shaft 125 feet deep. At 108 feet from the surface the length of the workings is about 200 feet. Samples were collected from 100 tons of washed ore (No. 791), and from 30 tons of rock-ore (No. 792). The samples contained—

	No. 791.	No. 792.
	Per cent.	*Per cent.*
Metallic iron	40.71	46.87
Phosphorus	0.142	0.124
Phosphorus in 100 parts iron	0.348	0.264

The *Cone* mine (25) is in the southern part of Richmond township, half a mile east of the Richmond furnace. a The mine is a very old one. Until 1873 it was worked entirely open-cut, but now the greater part of the ore comes from the underground workings. The shaft is 208 feet deep. In the census year the mine produced 7,827 tons of ore. The mine is worked by the Richmond Iron Company. All the ore is used in the company's furnaces. A sample from a pile of 1,000 tons of washed ore contained—

	No. 794.
	Per cent.
Metallic iron	41.80
Phosphorus	0.102
Phosphorus in 100 parts iron	0.244

b

The *Cheever* mine (26), located about 2 miles northeast of the Richmond furnace, is owned by John H. Cheever, and is worked by the Richmond Iron Company. From June 1, 1871, to June 1, 1877, 33,482 tons of ore were mined. In the census year the production was 12,034 tons. The workings are principally underground. There are several shafts; the deepest of these is 160 feet. An exceptionally large amount of rock-ore is found in this deposit. Samples from 300 tons washed ore (No. 799) and 25 tons of rock-ore (No. 800) contained—

	No. 799.	No. 800.
	Per cent.	*Per cent.*
Metallic iron	45.82	43.82
Phosphorus	0.168	0.234
Phosphorus in 100 parts iron	0.367	0.534

c

The *Bank* mine (27) adjoins the Cheever on the west, and is on the same body of ore. It is owned and worked by the Stockbridge Iron Company. The ore is used at the Pomeroy iron-works. The mine was worked eight months in the census year, and produced 5,040 tons of ore. Samples were collected from the stock-pile at the Pomeroy furnace. These samples contained—

	No. 795.	No. 796.
	Per cent.	*Per cent.*
Metallic	39.12	50.48
Phosphorus	0.248	0.183
Phosphorus in 100 parts iron	0.634	0.363

d

Sample No. 795 represents the fine material in a pile of 2,000 tons of a mixture of rock and washed ore, and sample No. 796 the rock-ore in the same pile.

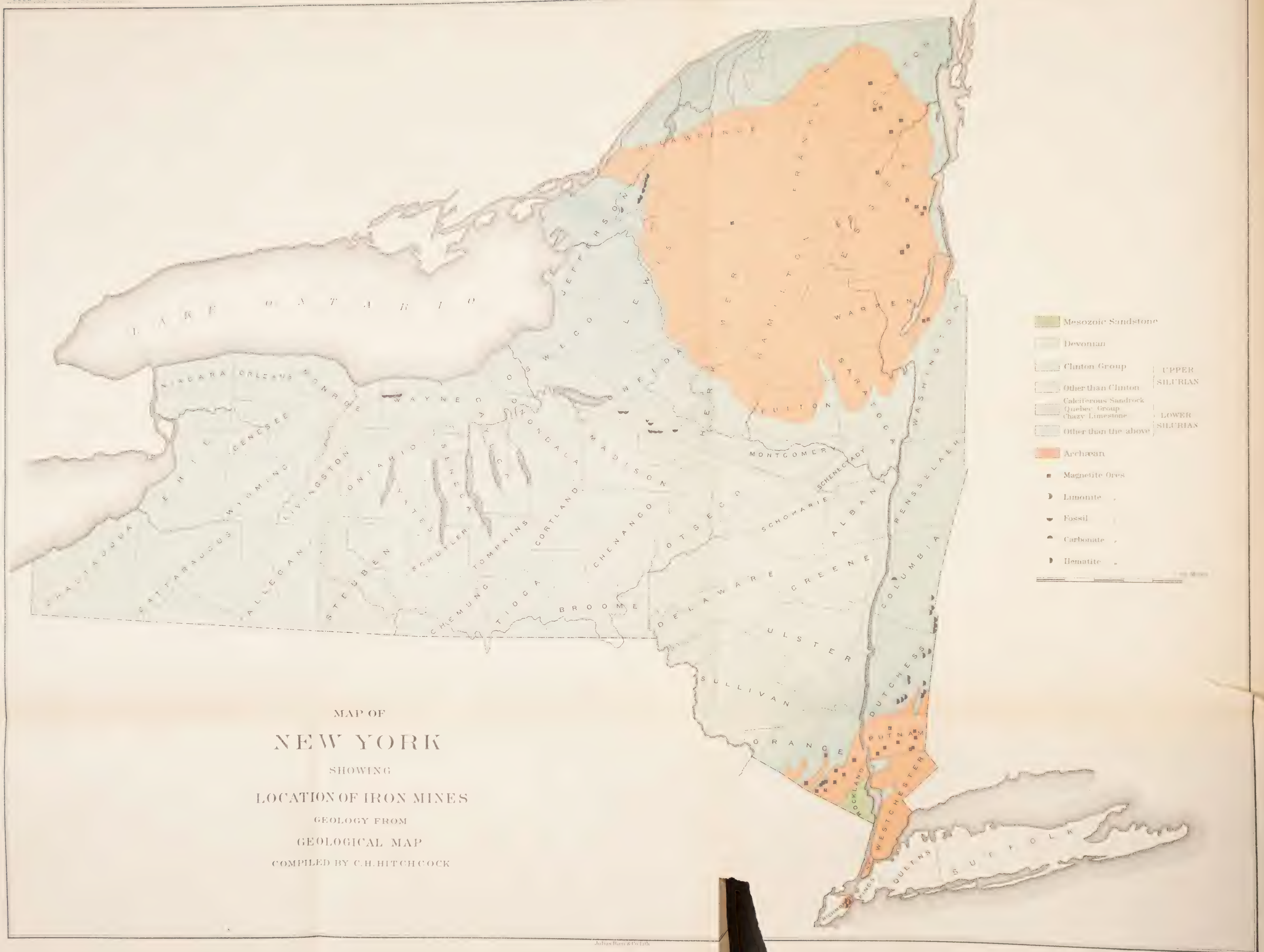
The *Bacon* mine (28), located at the western foot of mount Osceola, about 1½ miles northeast of the Cheever, is owned by Bacon & Andrews, and was reopened in April, 1880, by the Pomeroy Iron Company, after having been idle for a number of years. Before the close of the census year 280 tons of ore were raised. The mine was first e opened in 1846, and its total production of ore is estimated at 28,000 tons. The present workings consist of a shaft 50 feet deep, from the bottom of which drifts have been driven north and south 60 and 50 feet, respectively. The original workings were in an open cut, now filled with water. Samples of the ore from the stock-pile at the Pomeroy furnace, to which all the ore is sent, yielded on analysis—

	No. 797.	No. 798.
	Per cent.	*Per cent.*
Metallic iron	43.17	49.83
Phosphorus	0.999	1.249
Phosphorus in 100 parts iron	2.314	2.507

f

Sample No. 793 represents the fine ore in a pile of 300 tons of washed and rock ore, and sample No. 798 the rock-ore in the same pile.

Ore has been dug in many localities in Richmond township other than those above mentioned, but the beds referred to are the only ones recently worked. In Lanesborough township some ore was raised by its owner, J. L. Colby, from the Sherman mine (29), 2 miles west of the village of Lanesborough; and 1,367 tons of ore were raised in the census year from the Mason & Bliss mine (30) in Cheshire township. These mines were not sampled.



Julius Bien & Co. Lith.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN NEW YORK.

By Bayard T. Putnam.

The iron ores of New York may be conveniently grouped according to their mineralogical character and their geographical occurrence as follows:

I. Magnetite ores: (*A*) Of Orange and Putnam counties. (*B*) Of Washington, Essex, Clinton, Franklin, and Saint Lawrence counties.

II. Limonite ores: Of Richmond, Orange, Dutchess, and Columbia counties.

III. Carbonate ore: Of Columbia county.

IV. Fossil ores: Of Oneida and Wayne counties.

V. Hematite ore: Of Jefferson and Saint Lawrence counties.

On the accompanying map (Plate XXV) the localities where the different kinds of ore are mined are indicated by special symbols.

I. Magnetic ores.

A.—ORANGE AND PUTNAM COUNTIES.

The belt of Archæan rocks extends northeastward from New Jersey into Orange and Rockland counties; thence crosses the Hudson river into Westchester and Putnam counties. On the northwest it is overlaid by Lower Silurian slates and limestones, and on the southeast, in Rockland county, it is covered by Triassic sandstone. The character of the belt is much the same as in New Jersey. The magnetic oxide of iron is widely distributed through the rocks, and has been mined in all the above-named counties. In the census year, however, no ore was produced in Rockland or in Westchester county.

The locations of the iron mines at present worked are shown on fig. 12.

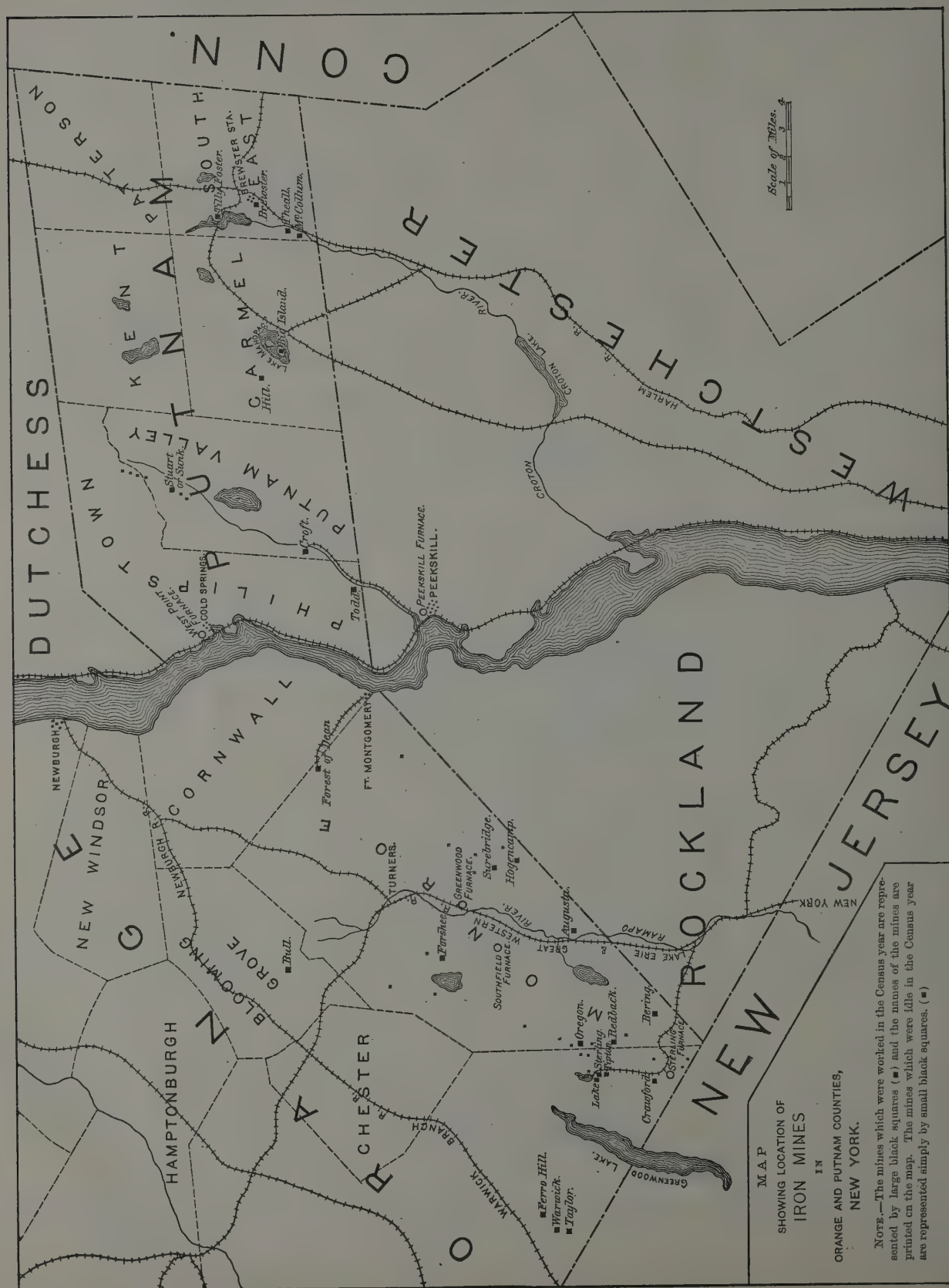
ORANGE COUNTY.

Extending northward from the state line, in Warwick and Monroe townships, is a tract of 25,000 acres of land, a portion of a grant to Lord Sterling, which is now owned by the Sterling Iron and Railway Company. On this tract are the Crawford, Bering, Redback, Sterling, Lake, Tiptop, Scott, and other mines, and the Sterling and the Southfield furnaces. The Sterling Mountain railroad, owned by the company, connects the mines with the New York, Lake Erie and Western railroad.

The *Crawford* mine is in the southeastern part of Warwick township, about 1 mile from the state line. The mine was opened in 1792. In the census year it produced 2,240 tons of ore. The old workings extend along the side of the mountain, but are nowhere very deep. The vein is very irregular in width. The pit now worked is 40 feet deep, and the stope is about 15 feet wide. The ore is fine-grained and contains pyrite and apatite. A sample from a pile of 400 tons at the mine contained—

	No. 400.
	Per cent.
Metallic iron	57.66
Phosphorus	2.004
Sulphur	0.178
Manganese	Present.
Titanic acid	Present.
Phosphorus in 100 parts iron	3.476

The *Bering* mine, east of the Sterling furnace, produced 2,688 tons of ore in the census year. The ore was not sampled.



MAP
SHOWING LOCATION OF
IRON MINES
IN
ORANGE AND PUTNAM COUNTIES,
NEW YORK.

NOTE.—The mines which were worked in the Census year are represented by large black squares (■) and the names of the mines are printed on the map. The mines which were idle in the Census year are represented simply by small black squares. (■)

The *Redback*, or *Spruce Swamp*, mine is located on the top of Sterling mountain, about 3 miles from the Sterling **a** furnace. It produced in the census year 3,638 tons of ore. Although an old mine (it was discovered in 1780), the ore contains so much pyrite that but little of it has been used until recently. Along the outcrop, owing to the oxidation of the pyrite, the ore is red in color, and this has given the mine its name. The mine is worked in open-cut, which is perhaps 20 feet deep. The vein dips at about 25° to the southeast. It varies in width, but averages perhaps 12 feet. The ore is teamed to the foot of the mountain, and is used at Sterling and at Southfield. A specimen of the unaltered ore contains a considerable quantity of green mica, besides pyrite and pyrrhotite. The magnetite is granular or in imperfect crystals, and has a bright metallic, sometimes splendent, luster. A sample taken from a few car-loads of the ore contained— **b**

	No. 701.
	Per cent.
Metallic iron	52.93
Phosphorus	0.028
Sulphur	3.603
Phosphorus in 100 parts iron	0.053

The *Sterling* mine is the largest on the tract. It is situated near the south end of Sterling pond, about 2 miles north of Sterling furnace. It was discovered in 1750, and the following year a furnace was erected and **c** put in operation near the mine. The ruins of the old stack can still be seen. In the census year the Sterling, Lake, and Tiptop mines together produced 26,173 tons of ore. The greater part of this amount was mined at the Sterling.

The sketch (Fig. 13) shows about the relative position of these three mines. It is here inserted, however, more to show the remarkable change in the direction of the strike and dip of the strata in the neighborhood of Sterling pond. The dip is indicated by the arrows. **d** At the mine it is *toward* the north-northeast, and varies from 12° to 20°. According to Dr. Horton,(*a*) the "Sterling mine covers a surface of 30 acres by survey; part of this ore is bare, part of it is covered by soil 1 to 5 feet in depth, and part by rock 6 inches to a yard in thickness". All the ore from this immense outcrop has been removed, and the workings have been carried under a massive hanging wall or roof which is supported by pillars of ore. Along the northeast the ore has pinched down to a couple of feet or less in thickness. The **e** direction of this pinch is northwest and southeast, and the workings have been carried along it. They have passed under the brook and are possibly now under the lake, or at all events not far from it. The ore varies in thickness from 10 to 25 or 30 feet, owing to the rolls in the walls. These rolls are well exposed in the old open workings where the ore has been taken entirely off the floor, or foot-wall. The direction and pitch of their axes is toward the northwest. The rock near the ore is hornblendic gneiss and granite. Along the ridges of some of the rolls the gneiss is bent in a curve of a few feet radius.

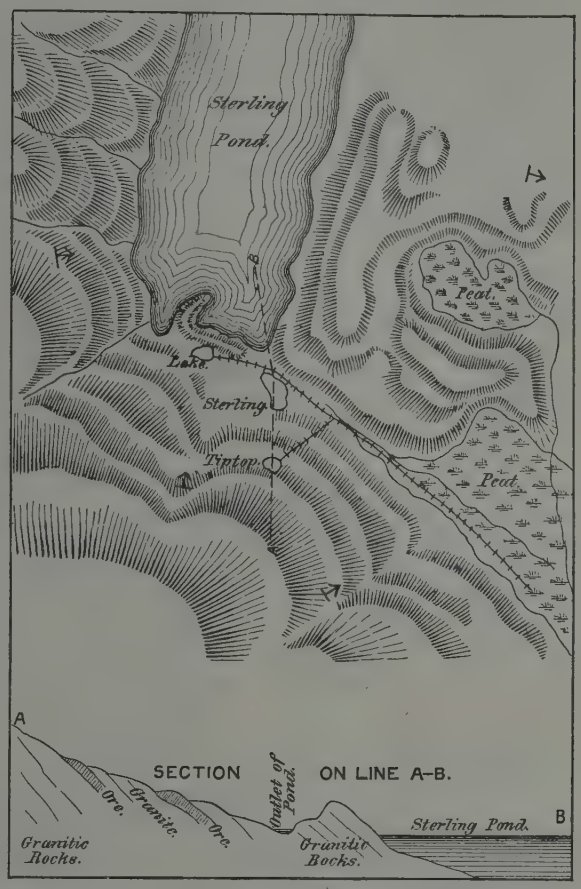


FIG. 13.—SKETCH OF THE STERLING IRON MINES AND VICINITY. Chiefly from *Geology First District of New York*, plate 30, figs. 4 and 5.

The greater part of the ore is a granular magnetite with more or less apatite; it is represented by sample No. 705, taken at the mine from a pile of about 250 tons. A separate sample (No. 706) was collected from a variety of ore, in which the magnetite is in large, tabular crystals, having a bright metallic luster. It contains a little hornblende **f** and quartz, but is apparently almost pure magnetic oxide, and is a beautiful-looking ore. It lies in a narrow seam in the main mass. The samples contained—

	No. 705.	No. 706.
	Per cent.	*Per cent.*
Metallic iron	61.01	67.75
Sulphur	0.371	0.365
Phosphorus	0.284	0.145
Phosphorus in 100 parts iron	0.465	0.214

a Geology of the First District of New York, William G. Mather, p. 570.

a The *Lake* mine is west of the Sterling, on the same bed of ore. The underground workings of the two mines are estimated to be about 200 feet apart. Although under Sterling pond the mine is very dry. The ore resembles the Sterling ore. A sample from 50 tons of the ore on the cars contained—

	No. 704.
	Per cent.
Metallic iron	57.25
Sulphur	0.088
Phosphorus	1.205
Manganese	Present.
Phosphorus in 100 parts iron	2.105

b The *Tiptop* or *Summit* mine is on the hillside above the Sterling, and is on a vein of ore which appears to underlie the main vein, as is shown on the section (Fig. 13). The mine is a small one, and has been worked under the hanging-wall but a short distance. A tunnel through the hanging-wall at a level with the bottom of the mine enables the ore to be run out without the aid of machinery. The tram-cars are run to the bottom of the hill on a gravity incline, where the ore is dumped into pockets near the railroad. A sample of the ore from the cars contained—

	No. 702.
	Per cent.
Metallic iron	54.03
Sulphur	0.173
Phosphorus	1.751
Manganese	Present.
Titanic acid	Present.
Phosphorus in 100 parts iron	3.241

c

East and northeast of Sterling pond there are numerous old mines, but the only one recently worked is the *Scott* or *Oregon* mine, located in Monroe township, near the west township line, about 1 mile from the Sterling mine (or "Lakeville"). The strike of the vein is northeast and southwest, and the dip is at a steep angle toward the southeast. The ore is 5 to 6 feet wide. A portion of the ore is teamed directly to Southfield furnace (7 miles), and d the remainder is carted to Lakeville, whence it is shipped by rail. A sample of the ore from the cars contained—

	No. 703.
	Per cent.
Metallic iron	62.59
Sulphur	0.082
Phosphorus	0.711
Titanic acid	Present.
Manganese	Present.
Phosphorus in 100 parts iron	1.136

e The ore is finely granular, and has a schistose structure. It contains apatite. In the census year 5,783 tons of ore were mined.

Greenwood mines.—Of the several old mines east of the Greenwood furnace and owned by the Parrott Iron Company, the Hogencamp was alone worked to any extent in the census year. A little ore was, however, raised from the Pine Swamp, Greenwood, and Surebridge mines. The three mines produced 755 tons of ore, and of this 458 tons came from the Surebridge mine.

The *Hogencamp* mine is about 5 miles from the furnace by road. The vein has been worked to a depth of 60 feet and a length of 250 feet. The walls dip steeply to the northwest, and are very irregular. The ore averages 12 to 15 feet in width. A portion of the ore resembles sample No. 706, but it contains pyrrhotite and pyrite in quantities. A sample from a pile of 100 tons contained—

	No. 707.
	Per cent.
Metallic iron	52.93
Sulphur	2.399
Phosphorus	0.033
Manganese	Present.
Phosphorus in 100 parts iron	0.062

The *Forshee* mine, sometimes called the "O'Neil" or "Nail" mine, is located a half mile southwest of the old O'Neil mine proper, and about 2½ miles due west of the Greenwood furnace. It was reopened in January, 1880,

and produced about 2,000 tons of ore before the end of June, when work was stopped. The mine is worked in a open-cut and a large amount of rock has to be moved, as the ore is in layers which alternate with layers of rock. The ore varies in texture; the magnetite is often in quite large grains, which have a more or less perfect octahedral form and splendent luster. Dr. Horton (*a*) found associated with the ore, red garnet, brown tremolite, green coccolite, serpentine (yellow and black), calcareous spar, asbestus, and mica. A sample from a pile of 75 tons of ore at the furnace contained—

	No. 708.
	Per cent.
Metallic iron	40.33
Phosphorus	0.020
Sulphur	0.453
Manganese	Present.
Phosphorus in 100 parts iron	0.050

b

The old *Clove* mine, about 2 miles northeast of the Forshee, was worked in the month of April, 1880, and about 15 tons of ore were mined. It was not visited.

The *Bull* mine is located about 2¾ miles north from the Clove mine, and 2 miles northeast from Oxford, in Blooming Grove township, on the top of Pedlar's hill. The upper portion of this hill is gneiss, surrounded on all sides by Lower Silurian slates. The mine is the most northerly one in Orange county. The ore lies in a shoot which pitches with the dip to the southeast at an angle of 25°. Its horizontal width is about 100 feet, its thickness 10 feet, and it is said to have been worked to a depth of 1,000 feet; but the deep part of the mine is now filled with c water. In the census year 2,579 tons of ore were raised. This was mined within 100 feet of the surface, principally from an old pillar. The total production of the mine is estimated at 52,000 tons. A sample of the ore from a pile of 100 tons at the furnace contained—

	No. 709.
	Per cent.
Metallic iron	51.30
Phosphorus	0.390
Sulphur	0.464
Titanic acid	Present.
Manganese	Present.
Phosphorus in 100 parts iron	0.760

d

The ore is very finely granular or compact in texture.

The Forshee, Clove, and Bull mines belong to the Parrott Iron Company, and the ore is all used in the Greenwood furnace, after being first roasted in heaps.

In the southern part of Warwick township, 2 or 3 miles south of the village of Warwick, and not far from the New Jersey state line, the Taylor, Warwick, and Ferro Hill mines are located, and were worked in the census year

The *Taylor* mine, belonging to Isaac Taylor, and operated by the owner, produced 896 tons of ore.

The *Ferro Hill* mine, owned by the estate of J. Mayir, L. Birdseye, *et al.*, and worked by M. Standish, produced e 353 tons of ore. Its total production is estimated at 4,000 tons.

The *Warwick* mine is owned and worked by the Parrott Iron Company. It produced 4,464 tons of ore in the census year. Its total production is estimated at 52,375 tons.

The above-named mines were not visited, but a sample was taken of the ore from the Warwick mine at Greenwood furnace. The vein is reported to be 4 to 5 feet wide and to have been worked to a depth of 185 feet. The ore contains much pyrrhotite. The sample yielded on partial analysis—

	No. 710.
	Per cent.
Metallic iron	52.35
Phosphorus	0.092
Sulphur	2.748
Phosphorus in 100 parts iron	0.175

The *Forest of Dean* mine is about 7 miles northeast of Greenwood furnace and 3½ miles northwest of Fort Montgomery, near the northeastern boundary line of Monroe township. It is owned and operated by the Forest of Dean Iron Ore Company. The ore is used in the Poughkeepsie Iron Company's furnaces, to which it is sent via tramroad to Fort Montgomery, thence by boat up the Hudson river. In the census year the mine produced 23,555

a Geology of First District, p. 573.

a tons of ore. The mine has been worked for many years, and its total production must have been large, but the figures were not obtained. The ore-mass is in the form of an immense shoot, which has the usual southeast dip and northeast pitch. The skiproad is laid on the "bottom rock" and is 1,200 feet long. The pump-shaft is about 900 feet northeast of the top of the slope; it is vertical and is 300 feet deep; hence the pitch of the chute of ore is one in three. An approximate section of the chute is shown in Fig. 14. The dimensions are estimated. Lines to indicate the stratification planes of the gneiss are purposely left out, as the relation of the ore-mass to the inclosing rock was not fully determined. The strike and dip of the ore was, at the surface, the same as the strike and dip of the gneiss; but the question is, is the "bottom rock" formed by a narrow synclinal fold? Such a fold appears to be a probable explanation of the peculiar shape of the ore-body. The mine

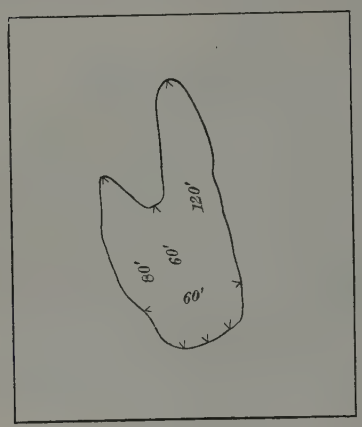


FIG. 14.

b was originally worked in open-cut. A section through the old pit is given by Professor Mather.(a) The mass of rock there marked "granite" is now seen to only partially divide the body of ore. Much of the ore is coarsely granular or "shotty", and it often contains white or flesh-colored calcite. Crystalline limestone occurs near the ore, but not in direct contact with it. A sample from a pile of about 2,000 tons of the ore at the mine contained—

c

	No. 711.
	Per cent.
Metallic iron	63.00
Phosphorus	0.621
Sulphur	0.148
Phosphorus in 100 parts iron	0.985

Iron ore has been mined at numerous other points along the Highlands west of the Hudson river, both in Orange and Rockland counties. The mines were small, however, and, with the exception of ore near Queensborough, have not recently been worked.

Two samples were collected at the West Point furnace (Coldspring) from piles of ore which had lain at the furnace for several years. These samples contained—

d

	No. 725.	No. 730.
	Per cent.	*Per cent.*
Metallic iron	39.93	44.47
Phosphorus	0.072	0.061
Phosphorus in 100 parts iron	0.180	0.137

The ore represented by sample No. 725 came from Stevens' mine, on Long mountain, near Fort Montgomery. That represented by sample No. 730 was shipped to the furnace from Verplanck point, Westchester county. But whether mined there or on the west side of the river is uncertain. When the sample was taken the superintendent of the furnace thought he could ascertain where the ore was mined, but this, he afterward wrote me, he was unable to do.

e

PUTNAM COUNTY.

The *Todd* mine is located in the southern part of Phillipstown township. It is owned and worked by the Fallkill Iron Company, and the ore is sent to the company's furnaces at Poughkeepsie via a narrow-gauge railroad to the Hudson river at Peekskill and thence by boat. During the census year 4,032 tons of ore were mined. The accompanying sketch (Fig. 15) shows the extent of the workings. Crystalline limestone forms the east wall of the main pit, and is seen outcropping to the *west* of the line between this pit and the "old opening", where it seems to have a direction at an angle with the strike of the ore. The old opening had caved in, but the superintendent of the mine assured me that considerable ore had been taken from it, and that a drift had been driven from one pit to the other through limestone. It was his belief that the limestone cut across the ore. A possible explanation of this

f is that there are here two shoots of ore, one near the upper part of the bed of limestone and one near the lower part of the same bed. At the tunnel, northeast of the main pit, the vein of ore is 3 to 4 feet wide. The sink is 25 to 30 feet below the surface. Very little ore has thus far been taken from this opening. Two samples of the ore were collected. They contained—

	No. 723.	No. 724.
	Per cent.	*Per cent.*
Metallic iron	44.34	47.58
Phosphorus	0.033	0.087
Phosphorus in 100 parts iron	0.074	0.183

a *Geology of First District*, Plate 5, Fig. 9.

Sample No. 723 is from 400 tons of the ore on the dock at Peekskill—all from the main pit. Sample No. 724 **a** is from a few tons of ore at the entrance to the tunnel. The ore contains calcite and a little pyrrhotite.

The *Croft* mine is northeast of the Todd, in Putnam Valley township. It is 9 miles by the railroad from the dock at Peekskill. The mine is owned by T. G. S. Flint and George C. Clark, and is operated by W. H. Campbell. It was reopened in 1880, after having been idle for five or six years. No ore was raised in the census year. The accompanying sketches (Fig. 16) were copied from the owners' plan of the mine, which was kindly loaned to me for the purpose. The ore averages 10 feet in width, and the work since the survey was made has removed it to a point below the "level of the proposed tunnel". The "Sketch at the end of the gangway, E", is **b** by Mr. Fulton. That portion of the mine was filled with water when visited by me, and the remarkable fold in the hanging-wall there figured was not seen. The mining operations were all in the "old workings" or "pit No. 1". A sample from a pile of 285 tons of the ore on the dock from this part of the mine raised several years since contained—

c

	No. 721.
	Per cent.
Metallic iron	59.83
Phosphorus	0.012
Phosphorus in 100 parts iron	0.020

A sample from 185 tons of ore from the top stope of the "new workings", or pit No. 2, called "No. 2 ore", contained—

d

	No. 721.
	Per cent.
Metallic iron	54.08
Phosphorus	0.066
Phosphorus in 100 parts iron	0.122

No. 2 ore differs from No. 1 in containing more quartz and pyrrhotite.

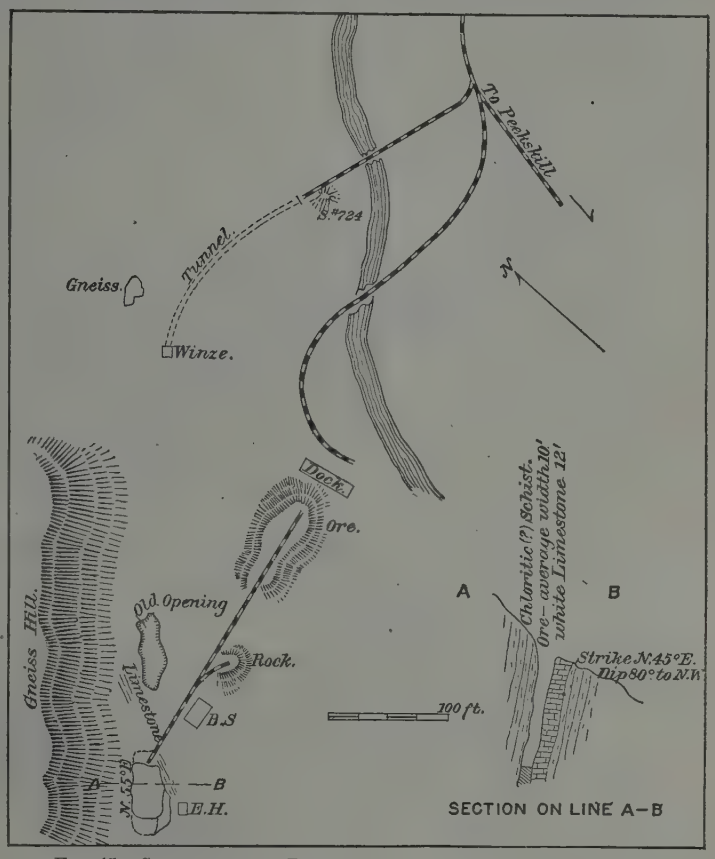


FIG. 15.—SKETCH OF THE TODD MINE, PUTNAM COUNTY, NEW YORK.

The following analyses were recently made for the company, and are here inserted for comparison: **e**

	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Magnetic oxide of iron	89.388	77.636	.....
Alumina	1.649	3.084	.....
Manganese	None.	None.	.....
Lime	0.355	0.660	.....
Magnesia	0.886	0.995	.....
Phosphoric acid	0.011	0.013	.....
Sulphur	1.047	2.018	.....
Silicious matter	6.650	16.335	.....
	99.986	100.741	.....
Metallic iron	64.729	56.219	64.06
Sulphur	1.047	2.018	1.14
Phosphorus	0.005	0.006	0.008
Silica	3.140	8.785	4.03
Phosphorus in 100 parts iron	0.007	0.010	0.012

f

Analyses Nos. 1 and 3 are of samples of ore from pit No. 1. Analysis No. 2 is of ore from the top stope in pit No. 2. Analyses Nos. 1 and 2 were made by Booth, Garrett, and Blair, May 6, 1880. Analyses No. 3 was made by the chemist of the Cambria Iron Company.

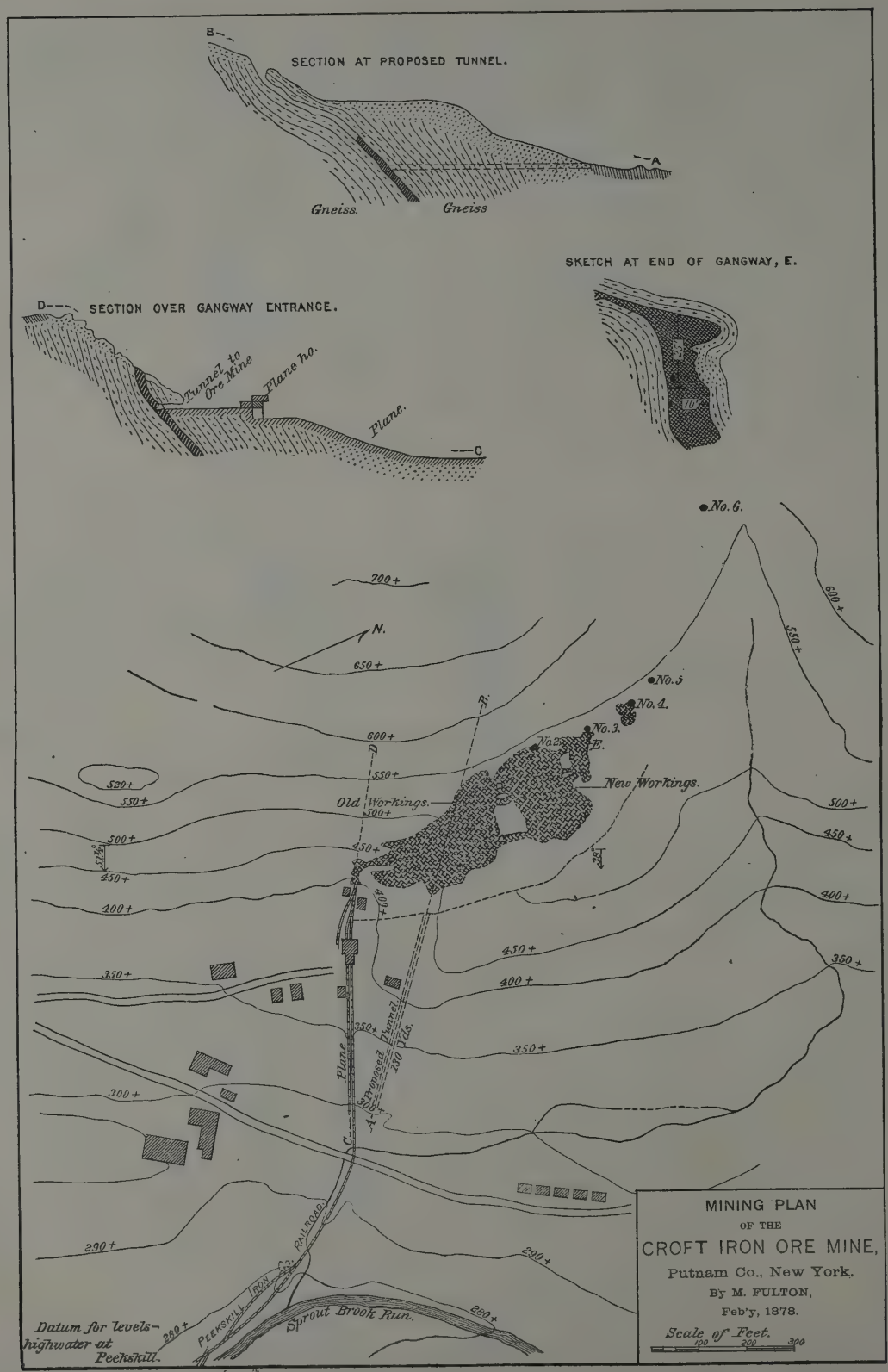

SECTION AT PROPOSED TUNNEL.
B
A
Gneiss.
Gneiss
SKETCH AT END OF GANGWAY, E.
D
SECTION OVER GANGWAY ENTRANCE.
Tunnel to Ore Mine
Plane ho.
Plane.
C
No. 6.
700+
N.
650+
600+
550+
520+
500+
450+
400+
350+
300+
290+
280+
No. 5
No. 4.
No. 3.
No. 2
E.
New Workings.
Old Workings.
Plane
Proposed Tunnel 300 Feet.
RAILROAD
PEEKSKILL IRON CO.
Sprout Brook Run.
Datum for levels—highwater at Peekskill.
MINING PLAN
OF THE
CROFT IRON ORE MINE,
Putnam Co., New York.
By M. FULTON,
Feb'y, 1878.
Scale of Feet.
100
200
300

FIG. 16.

In the northern part of Putnam Valley township numerous openings have been made along an outcrop of ore **a** which seems to be the extension of the Todd-Croft belt. On this belt the *Stuart* or *Sunk* mine is located on the east side of a mountain ridge, about 7 miles due east from Coldspring. The mine is owned by the Reading Iron Company. No ore has been mined for several years, but in the spring of 1880 the pumps were started and the mine was partly cleared of water; but owing to the financial embarrassment of the owners no active mining was done. The extent of the workings is shown on the sketch (Fig. 17). The dip of the ore is, as in the Todd mine,

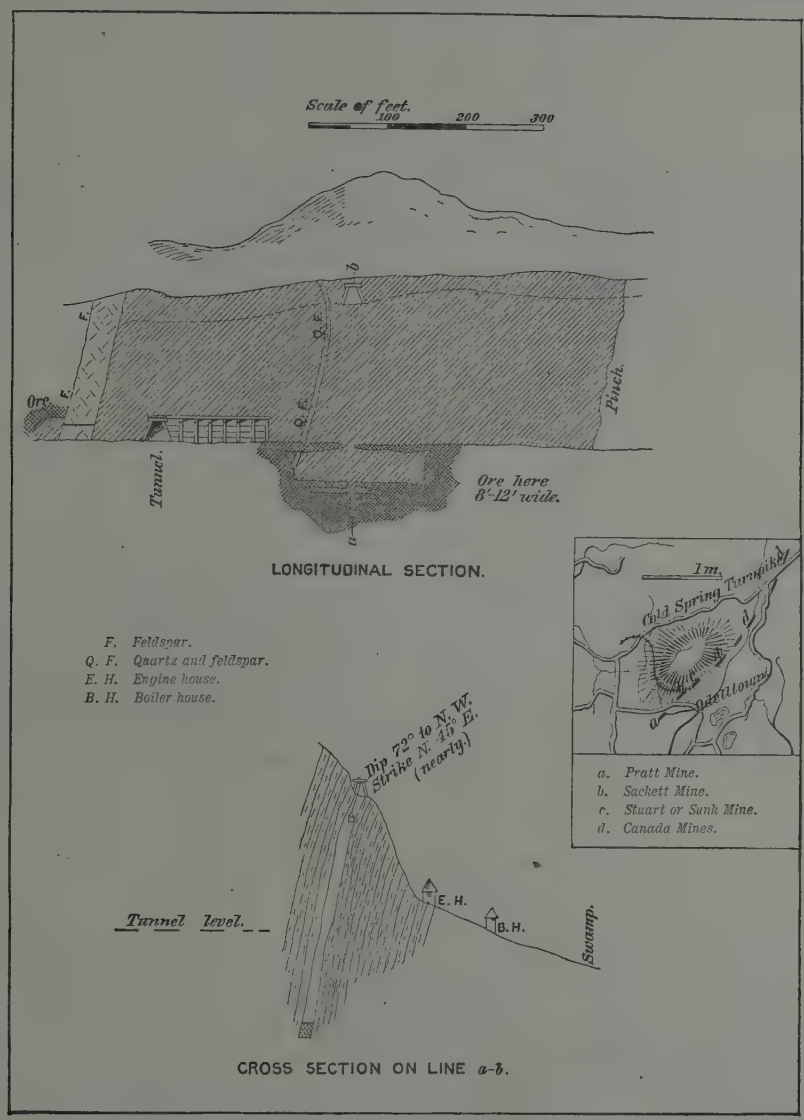


FIG. 17.—SKETCH OF THE STUART OR SUNK MINE, PUTNAM COUNTY, NEW YORK.

	No. 731.
	Per cent.
Metallic iron	57.23
Phosphorus	0.359
Titanic acid	Present.
Phosphorus in 100 parts iron	0.627

toward the northwest. At the tunnel-level the ore has been exploited for 700 feet. At the northeast end of the **f** workings it pinches down to a width of a few inches. At the southwest end it was entirely cut off by a "crossing" of feldspathic rock, but on drifting through this (about 50 feet) ore was found beyond. Only a little ore has been taken from this part of the mine, however. A sample of the ore was taken from a pile of 100 tons at the mine; the ore came from the sink. The sample contained—

a The *Pratt* and *Sackett* mines are southwest of the Stuart. The vein can readily be traced over the hill by the surface-workings. The shafts of the two mines are about 250 yards apart. The ore in the Pratt mine is reported to be 2 to 4 feet wide, and that in the Sackett mine about 5 feet wide. The Sackett shaft is about 75 feet deep. Some ore was raised from these pits eight years ago and teamed to the West Point furnace. A sample taken there from a pile of 175 tons contained—

	No. 726.
	Per cent.
Metallic iron	57.23
Phosphorus	0.663
Phosphorus in 100 parts iron	1.158

b

The *Denny* mine, situated southwest of the Pratt, and owned by the Parrott estate, was worked for a short time early in 1880 by the Thomas Iron Company. About 75 tons of ore were raised. The mine was not visited.

Northeast of the Stuart mine there is a long line of pits extending across the Cold Spring turnpike and known as the *Canada* mines. No ore has been raised from them for several years.

A sample was taken from a pile of 30 tons of ore at the West Point furnace, which came from the Rose mine, "on Peter Gilrichie's farm near Foshay corners, Kent township." The opening is reported to be 150 feet long and 10 feet deep, and the ore is said to be 5 feet wide. No work has been done at the locality for twenty years. The sample contained—

c

	No. 727.
	Per cent.
Metallic iron	51.90
Phosphorus	0.064
Manganese	Present.
Phosphorus in 100 parts iron	0.123

Early in May, 1880, the Lake Mahopac Iron Company began active explorations near German Flats, Carmel township, 1½ miles north of Red Mills. The locality is designated the *Hill* mine on the map (Fig. 12). The extent of the developments in the middle of August is shown in Fig. 18.(*a*) In the open cut no hanging-wall rock has been d encountered. The foot-wall is gneiss. From this pit about 2,000 tons of ore have been raised. Shaft No. 1, 240 feet northeast of the cut, is 110 feet deep. About 100 tons of ore have been taken from it, but the vein is narrow, and a drift is being driven westward in search of something better. No good ore has yet been met with in shaft No. 2. A little "mixed" ore was, however, brought up in the last few bucket-loads. The ore from the open pit is of excellent quality, as is shown by the following analysis of a sample taken to represent an average of a pile of 2,000 tons:

	No. 732.
	Per cent.
Metallic iron	61.87
Phosphorus	0.010
Phosphorus in 100 parts iron	0.016

e

The ore contains but little, if any, pyrite.

a In a paper entitled "The Iron Mines of Putnam County, New York", read at a meeting of the American Institute of Mining Engineers in September, 1884, Mr. Arthur F. Wendt states that an immense body of ore has been developed on this property. The shipments of ore had then amounted to 60,000 tons. A railroad was completed to the mine, and it was believed that the output in the future would be largely increased. "The mine practically assumes the shape of four beds of clean ore, from 10 to 50 feet wide, superimposed the one upon the other. Practically all the rock remains under ground and admirably answers the purpose of pillars." The horizontal section of the ore-body, or lens, is figured as roughly oval, the greatest width, at right-angles with the strike, being nearly 200 feet, inclusive, of course, of the interstratified rock. An "average analysis of samples just taken from 12,000 tons of ore, by Andrew S. McCreath", shows—

f

Sesquioxide of iron	52.018	Hygroscopic moisture	0.048
Protoxide of iron	22.885	Combined water	0.758
Bisulphide of iron	0.026	Silica	8.786
Protoxide of manganese	0.186	Alkalies and fluorine	0.427
Oxide of copper	None.	Total	100.000
Alumina	3.078		
Lime	1.450	Equivalent to—	
Magnesia	10.065	Metallic iron	54.225
Titanic acid	Trace.	Metallic manganese	0.144
Carbonic acid	0.251	Sulphur	0.014
Sulphuric acid	None.	Phosphorus	0.012
Phosphoric acid	0.028	Phosphorus in 100 parts iron	0.022

The ore is seen to resemble that from the Tilly Foster mine, in containing much magnesia and only trifling amounts of phosphorus and sulphur.

On Grand or Blackberry island, the larger of the two islands in Lake Mahopac, there is a vein of magnetic ore a which is reported to have been worked many years ago to supply a neighboring forge. It now belongs to Richard George, of Dover, New Jersey, and was worked for a few months in the census year, producing about 900 tons of ore. The greater part of this amount probably came from a pit 30 feet deep, 15 to 18 feet wide, and 20 feet long, near the southeastern side of the island. Northeast of this opening some ore was taken out from an open cut 3 to 4 feet

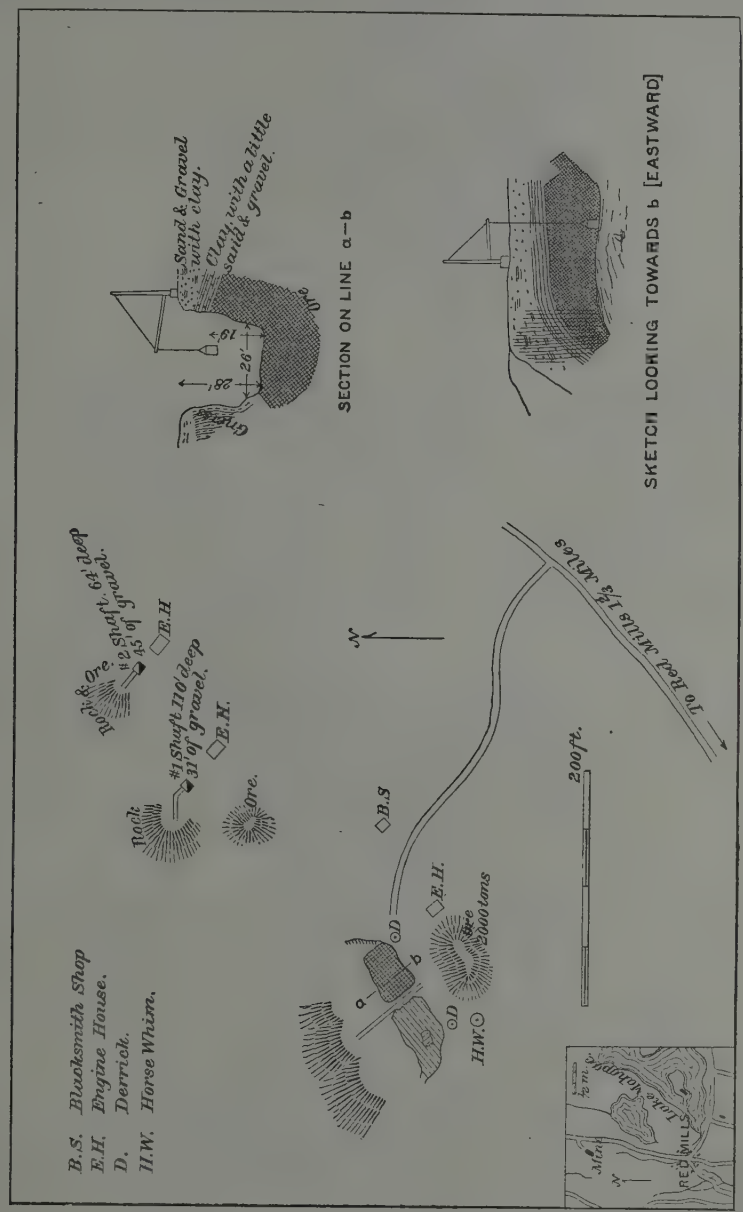


Fig. 18.—Sketch of the Lake Mahopac Iron Company's Mine, Putnam County, New York.

f

wide. The vein appears to be small and irregular. Its extension southwestward onto the mainland has been opened upon not far from the Dean house. A sample of the ore from the island was taken from a pile of 100 tons at the West Point furnace. It contained—

	No. 729.
	Per cent.
Metallic iron	44.34
Phosphorus	0.021
Manganese	Present.
Phosphorus in 100 parts iron	0.047

a The *Theall* and *McCollum* mines are located in the southwest corner of Southeast township, on opposite sides of the same ridge (see Fig. 19). They are owned and operated by a company known as the "Cheever and Durant Iron mines". The *McCollum* mine was opened in January, 1880. It is worked in open cut, and the ore is run out

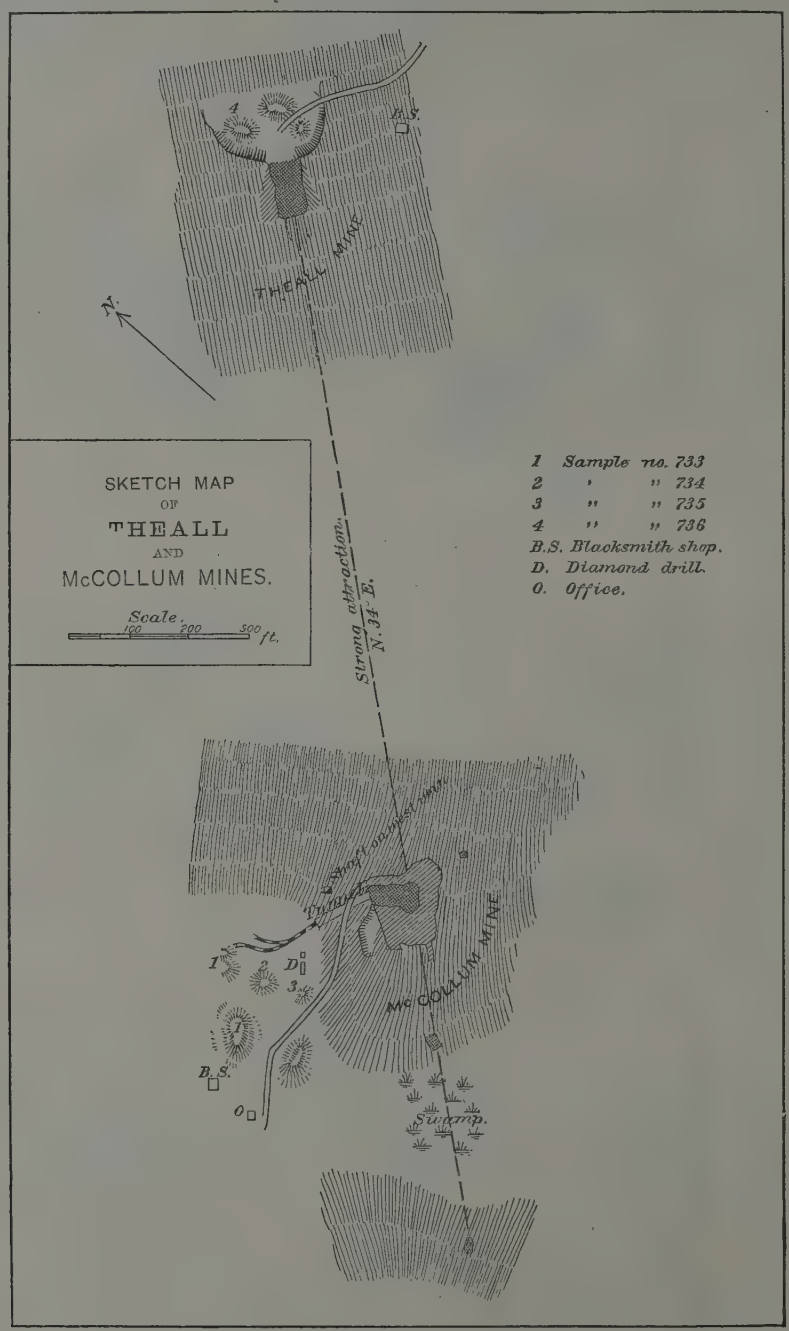


FIG. 19.

through a tunnel on a level with the bottom of the pit. The ore-body is wide, but has no well-defined walls. The ore requires careful hand-picking. Two grades are made. No. 1 is supposed to carry over 50 per cent. metallic iron, and No. 2 over 40 per cent. Masses of pyrite occurring through the ore are picked out as far as possible. About 3,000 tons of ore are (August, 1880) piled at the mine. Of this 100 tons are No. 1, 1,000 tons No. 2, and

the remainder is unsorted; it is, however, chiefly No. 2. With the exception of sample lots sent to different Pennsylvania furnaces no ore has been shipped. Samples taken to represent the two grades of ore contained—

	No. 733.	No. 734.
	Per cent.	*Per cent.*
Metallic iron	43.22	51.48
Phosphorus	0.255	0.247
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.590	0.480

Sample No. 733 is from 1,000 tons No. 2 ore; sample No. 734 is from 100 tons No. 1 ore.

In driving the tunnel a narrow seam of ore was cut before the main mass was reached. A shaft has been sunk on this seam and about 25 tons of ore have been taken from it. A sample of this contained—

	No. 735.
	Per cent.
Metallic iron	59.83
Phosphorus	0.035
Manganese	Present.
Phosphorus in 100 parts iron	0.058

The great difference in the per cent. of phosphorus in the above and samples Nos. 733 and 734 is noticeable.

At the *Theall* mine a cut has been driven into the hillside on the vein for about 100 feet, and from the end of the cut a tunnel has penetrated the hill some 50 feet. The tunnel is all in lean ore. Over 5,000 tons of ore have been taken from the cut and tunnel and are now stocked at the mine. A sample from this pile contained—

	No. 736.
	Per cent.
Metallic iron	44.24
Phosphorus	0.260
Phosphorus in 100 parts iron	0.587

In its contents of iron and of phosphorus it is seen to agree closely with the "No. 2" ore from the McCollum mine (sample 733); it contains, too, about the same amount of pyrite.

The *Brewster* mine, at Brewster station, was reopened early in February, 1880, by the "Cheever and Durant

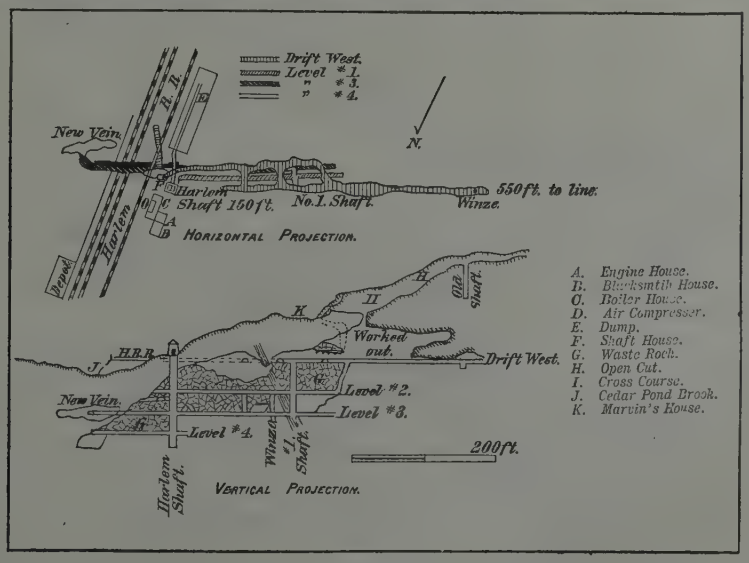


FIG. 20.

Iron mines", and 1,344 tons of ore were raised in the census year. Previous to this date the mine had been idle for five or six years. All the ore raised in the census year came from a pocket discovered by a drift from the third level, marked "new vein" on the sketch (Fig. 20). Considerable exploring was done after this pocket was exhausted,

a but as no more ore was found the mine was finally abandoned at the end of August. A sample from a pile of 500 tons of ore at the mine contained—

	No. 737.
	Per cent.
Metallic iron	64.09
Phosphorus	0.074
Phosphorus in 100 parts iron	0.115

The *Tilly Foster* mine is situated about 2 miles northwest from Brewster's station, Southeast township, near the
b north end of the recently-constructed storage-reservoir for the Croton aqueduct. It is owned and worked by the

c

d

e

f

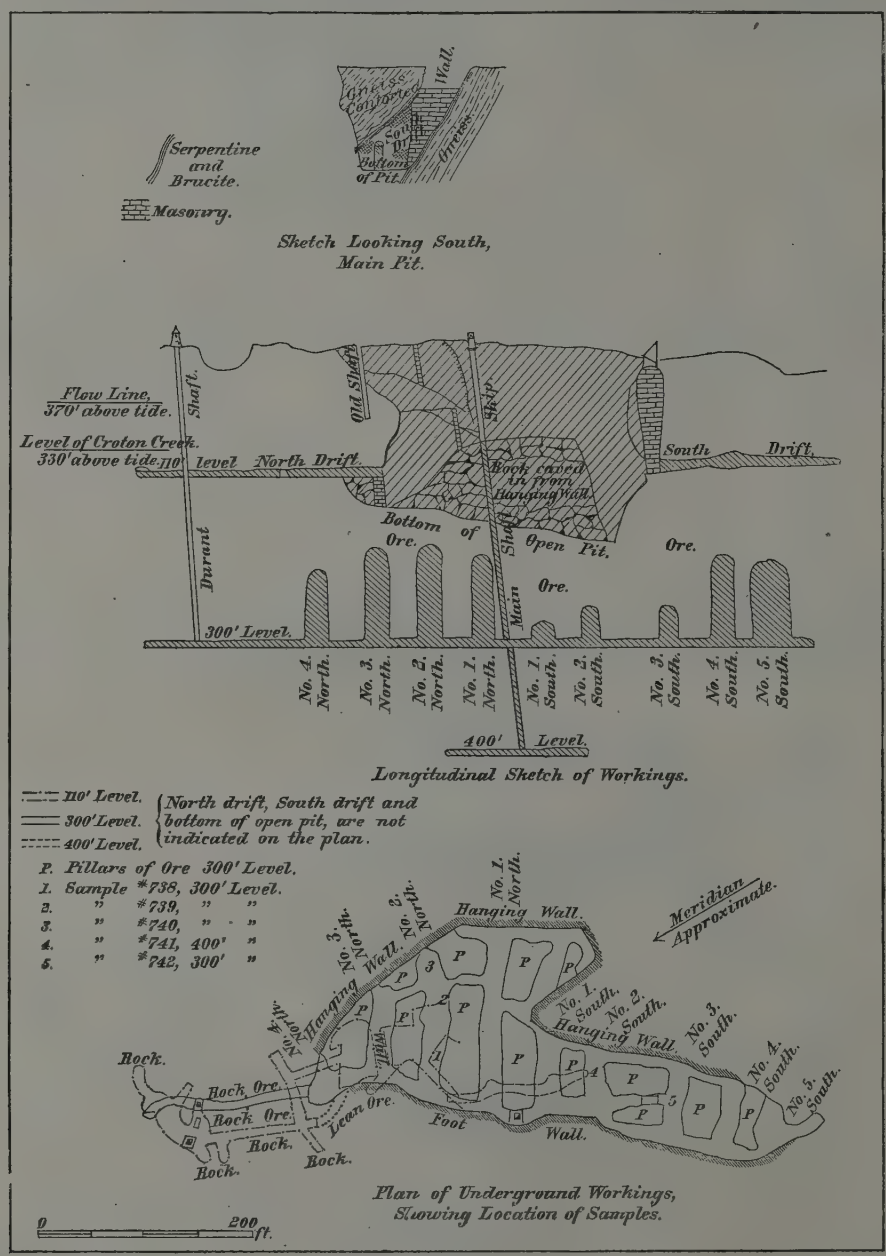


FIG. 21.

Lackawanna Iron and Coal Company. About 56,000 tons of ore were raised in the census year. In the shape of the ore-mass and in the minerals associated with the ore, the mine presents many exceptional features. The ore

has the general direction of the strike of the inclosing gneiss, and the foot-wall is quite regular and dips to the a southeast at an angle of about 70°, but the hanging-wall is extremely irregular, as is shown on the sketch (Fig. 21) of the plan of the 300-foot level. On this level the ore has been worked for a length of over 500 feet, and there is still ore in the end of the drift running south from "Room No. 5 south". The greatest width of the workings is through "Room No. 1 north", where it is about 164 feet. In "Room No. 4 south" the ore is about 70 feet wide, while in "No. 5 south" the hanging-wall has not been reached. From "Room No. 1 north" the walls rapidly approach each other in going northward. On the north side of "No. 4 north" there is only a narrow stringer of ore, and even this is lost in the drift to the Durant shaft, 40 feet from the room. The Durant shaft and all the drifts near it are entirely in gneiss rock.

Above the 300-foot level the wide portion of the ore-mass was exploited in an open cut to a depth of 120 feet. The ore widened as greater depth was reached through the dip of the hanging-wall becoming flatter. Large masses b of rock from the hanging-wall have fallen into the pit so that the width of the original outcrop of the ore cannot be seen. The sketch looking toward the south side of the pit indicates in a measure, however, the relative dip of the two walls. The contortion of the gneiss of the hanging-wall is a peculiar feature. On either side the ore is separated from the gneiss by layers of serpentine (with brucite) or layers of brown mica. Magnetite is distributed through these layers in varying proportions. So far as observed the gneiss contained no magnetite, differing in this respect from the rock usually found near masses of magnetic ore. (*a*)

About 110 feet below the surface, drifts extend both north and south from the open pit. The entrance to the north drift from the pit is closed by *débris* from the wall, but the drift can be entered through the Durant shaft. A chamber of ore is being worked out a short distance north of the pit. The ore is raised through the Durant shaft. c The ore from the south drift is raised through the open pit. A shaft has been sunk 100 feet below the 300-foot level, and a new level is being opened up.

The method employed in exploiting the ore on the 300-foot level (and the same system will be used on the 400-foot and lower levels) is by rooms and pillars. The rooms and pillars extend across the ore-mass, excepting where the latter are cut through by drift-ways. The formation of a room is begun at the level of the drifts, and the ore is blasted from the roof, or, in other words, the roof is "raised". The miners stand on the pile of broken ore and only the surplus ore is removed before the chamber has reached the desired height. When the blasting is finished, the broken ore is taken out of the chamber by laborers while the drilling-machines are at work in another room.

Room No. 2 north had been thus emptied, and a series of samples were taken across the side of the room to determine whether the composition of the ore varied with its position. Sample No. 738 consisted of numerous d chippings taken along the south side of the room from near the foot-wall to a point about one-third of the way across the room. The ore is finely granular and is largely mixed with serpentine and brucite. It has a cubical fracture. Sample No. 739 was taken from the south side of the room near the middle of the ore-mass. The ore resembles No. 738, but contains, perhaps, more serpentine and less brucite. It has a sub-conchoidal fracture. Sample No. 740 was collected from the north side of the room, near the hanging-wall. The ore contains little if any serpentine or brucite. These samples contained—

	No. 738.	No. 739.	No. 740.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	48.91	49.16	46.28
Phosphorus	0.015	0.030	0.017
Phosphorus in 100 parts iron	0.031	0.061	0.037

e

(*a*) In the paper referred to in the foot-note on page 98, Mr. Wendt gives an outline plan of the Tilly Foster mine at the surface and at the 110-foot level, and marks on each plan the position of a diagonal fault which was first suggested by Major T. B. Brooks to account for the shape of the ore-body. The northeast side of the pit, both at the surface and at the 110-foot level, is figured as a sharply flexed line, roughly parallel with the southwest boundary of the deposit, which is similar to that on the 300-foot level as represented in my figure 21. The plan on the 300-foot level does not show this flexure in the northeast boundary, though it is possible that if the "lean ore" marked on the sketch was removed, this boundary would be nearer like that on the higher levels.

The Tilly Foster mine has been so carefully studied by many of the foremost mining geologists of the country, that it is with much hesitancy that I offer any hypothesis of the structure of the ore-mass differing from the one above mentioned, which appears to have been generally adopted. But I cannot forbear noting the similarity between the plan of the 300-foot level of this mine and the section of the f Forest of Dean mine (Fig. 14), for instance, and to suggest the possibility (as a matter for future investigation) that the ore at the Tilly Foster mine may be concentrated along the axis of a compressed and overturned anticlinal, pitching northeasterly, and faulted, perhaps, more or less, on the line of this axis. There are a number of instances of the thickening of a seam of magnetite in the trough of a synclinal, and although I know of no case (unless this be one) of a similar concentration upon the ridge of an anticlinal, I can see no reason why this should not likewise take place under proper conditions. The contorted, and in places, granitoid condition of the gneiss in the southern wall of the open pit is suggestive of a compressed fold rather than of a simple fault.

a Sample No. 738 yielded on complete analysis—

	No. 738.		No. 738.
	Per cent.		*Per cent.*
Sulphur	0.548	Phosphoric acid	0.034
Phosphorus	0.015	Hygroscopic water	0.29
Iron, metallic	48.91	Water of composition	3.79
		Total	100.175
Silica	12.18		
Iron, protoxide	21.99	Per cent. of insoluble silicious matter	13.15
Iron, peroxide	44.75		
Alumina	0.79	Silica	12.18
Manganese, protoxide	0.10	Alumina (with a trace of oxide of iron)	0.32
Lime	3.10	Lime	0.29
Magnesia	11.72	Magnesia	0.27
Iron, disulphide	1.031		
Carbonic acid	0.40	Total	13.06

b

The following analyses are of samples taken from the different parts of the mine as explained below:

c

	No. 742.	No. 741.	No. 743.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	48.88	51.20	49.66
Phosphorus	0.006	0.016	0.007
Phosphorus in 100 parts iron	0.012	0.031	0.014

Sample No. 742 is from the roof of Room No. 3 south, 300-foot level. Sample No. 741 is from the sides of the drift, 400-foot level. Sample No. 743 was collected from the cars. It represents ore from the 110-foot level raised through the Durant shaft. This differs from the ore from the other part of the mine in that chondrodite forms its
d chief gangue.

Sample No. 743 was subjected to complete analysis, with results as follows:

	No. 743.		No. 743.
	Per cent.		*Per cent.*
Sulphur	0.538	Sulphuric acid	0.05
Phosphorus	0.007	Phosphoric acid	0.015
Iron, metallic	49.66	Carbon in carbonaceous matter	0.01
		Hygroscopic water	0.16
Silica	10.81	Water of composition	0.89
Iron, protoxide	23.36		
Iron, peroxide	44.30	Total	99.895
Alumina	1.11		
Manganese, protoxide	0.04	Per cent. of insoluble silicious matter	12.07
Lime	1.19		
Magnesia	16.33	Silica	10.81
Iron, disulphide	1.010	Alumina (with trace of oxide of iron)	0.68
Potassa	0.12	Lime	0.30
Soda	0.22	Magnesia	0.45
Carbonic acid	0.28	Total	12.24

e

A sample was collected from the cars to show the average output of the mine, exclusive of the 110-foot level.
f It contained—

	No. 744.
	Per cent.
Metallic iron	48.14
Phosphorus	0.018
Phosphorus in 100 parts iron	0.037

Selected chippings were also taken from the cars of a variety of ore with green mica (sample No. 745), and of a variety of apparently almost pure magnetite (sample No. 746). These samples contained—

	No. 745.	No. 746.
	Per cent.	*Per cent.*
Metallic iron	39.33	60.01
Phosphorus	0.039	0.014
Phosphorus in 100 parts iron	0.099	0.023

The ratio of phosphorus to iron in sample No. 745 is seen to be comparatively high. But the total amount of this variety of ore is so small that the general output of the mine could not be seriously affected by it.

B.—WASHINGTON, ESSEX, CLINTON, FRANKLIN, AND SAINT LAWRENCE COUNTIES.

WASHINGTON COUNTY.

The Archæan rocks come to the surface only in the northwestern part of the county, east of Lake George. In this narrow belt magnetic ore occurs at various localities, but it has recently been mined at two points only.

The *Potter* mine is located 4⅔ miles N. 40° W. from Fort Ann (see Fig. 22). It is owned by Joseph Potter, and was operated in the census year by John T. Harris & Son, who raised 12,172 tons of ore. A part of this was teamed

FIG. 22.—MAP OF A PORTION OF WASHINGTON COUNTY, NEW YORK, SHOWING POSITION OF IRON MINES.

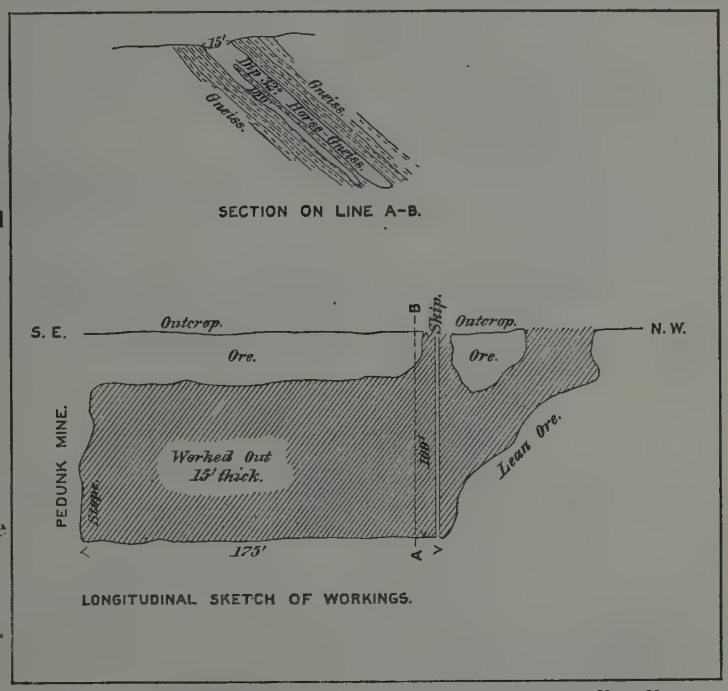


FIG. 23.—SKETCH OF THE POTTER MINE, WASHINGTON COUNTY, NEW YORK.

to the Fort Edward furnace (14 miles), and the balance to the canal at Fort Ann (8 miles), and thence shipped to the different Hudson river furnaces.

The mine is 250 feet northwest of the old Pedunk mine, which was operated many years ago, but has been idle for the past five or six years. The Potter mine was opened in 1879. It has one slope 100 feet in length on the foot-wall, which dips to the northeast at an angle of 32°. A section through this slope is shown on Fig. 23. The seam of rock which separates the ore into two layers increases in thickness toward the northwest, the layers of ore becoming correspondingly thinner. The line representing the limit of profitable working pitches to the southeast, as is shown on the longitudinal section. Southeast of the slope only the hanging-wall seam has been worked. The stope is 175 feet from the slope, and the ore is there 10 to 15 feet thick. The breast is not far from the underground workings of the old Pedunk mine.

Northwest of the slope the vein can be traced with the dip-needle across the brook. The attraction is slight, however, and explorations in this direction have thus far failed to find a workable body of ore.

The walls of the mine are a hornblendic gneiss of a light-gray color, excepting in immediate contact with the ore, where the color is darker, owing to the presence of more hornblende and of grains of magnetite. The ore is

a granular, occasionally "shotty", and contains more or less pyrite. In places it grades gradually into a magnetite-hornblende gneiss. A sample taken at the mine from a pile of about 1,500 tons of the ore raised since March 1 contained—

	No. 1177.
	Per cent.
Metallic iron	61.82
Phosphorus	Absent.
Titanic acid	Absent.

b About 3,000 tons of ore, mined during the past winter, are stocked near the canal at Fort Ann. The ore appeared to be much leaner than that in the pile sampled.

The *Mount Hope* mine is situated on the mountain of the same name, a half mile northwest of the Potter mine. It is owned by Joseph Potter, and was worked from 1879 to February or March, 1881, by W. P. Ostrander & Co.; 6,720 tons of ore were mined during the census year. The direction of the mountain spur on which the mine is located is nearly north and south, and the ore outcrops on the west, south, and east side of the ridge. It lies quite flat, dipping at from 5° to 10° to the northwest. Four openings have been made on the east side of the hill, and as many more on the west side, and altogether some 15,000 tons of "ore" have been mined and are now stocked near the several openings. Very little ore raised during the past two years has been shipped away. The principal opening consists of a tunnel, 20 to 30 feet wide, driven entirely through the hill nearly on the strike of the ore.
c At the western entrance the ore was about 10 feet thick; at 300 feet from this entrance a pocket of ore 25 feet in thickness was encountered. Beyond this, toward the east, the vein thins down to 3 to 4 feet. The ore has been removed along the south side of the tunnel nearly to the surface-workings from the outcrop. Work to the northward, *i. e.*, toward the dip, has been prevented by water, as there is no pumping-machinery at the mine. The length of the tunnel is between 500 and 600 feet.

Two or three hundred feet north of the western entrance to the tunnel a drift has been driven into the hill, on a seam of ore, 75 to 100 feet, in a southeasterly direction. At the end of this drift there are two seams of ore, 24 and 30 inches thick, separated by 30 inches of rock. North of this drift there are two other openings, now filled with water. I was told they were not extensive.

On the east side of the ridge north of the east tunnel entrance, and evidently on the same "vein" as is the
d tunnel, are two openings, and directly east of the entrance is a third opening which appears to be on another "vein" some 30 or 40 feet below the main one. All these pits were filled with water. The wall-rock is similar to that of the Potter mine.

The ore is finely granular in texture and is largely mixed with hornblende, and to a lesser extent with quartz, feldspar, mica, and, occasionally, pyrite. The greater part of the ore stocked at the mine is very lean, and probably would not average more than 25 to 30 per cent. of metallic iron. It might be hand-picked to run 35 to 40 per cent. A sample from a pile of ore near the western tunnel entrance (which pile appeared to contain better ore than the others) yielded—

e

	No. 1178.
	Per cent.
Metallic iron	36.99
Phosphorus	0.055
Titanic acid	Absent.
Phosphorus in 100 parts iron	0.149

ESSEX AND CLINTON COUNTIES (Fig. 24).

The ores of the Lake Champlain iron region, which is embraced in the above-named counties, at present mined may be grouped under the following heads:

First. Ores high in phosphorus but low in sulphur.

Second. Ores low in both phosphorus and sulphur.

f *Third.* Pyritous ores (usually low in phosphorus?).

Fourth. Titaniferous ores.

Ore of the first class forms the bulk of the shipments from the region. It is mined at the following localities, all in Moriah township, Essex county: *Mine* 21, *Old Bed*, and *Smith* mine (or Cook's shaft), at Mineville, and the *Cheever* mine near Port Henry. In the census year these four mines produced 457,460 tons of ore. The ore averages over 60 per cent. metallic iron.

Mines producing ore of the second class are more numerous and more widely distributed, but the deposits are as a rule smaller, and the ore contains less than 50 per cent. metallic iron. In the census year 259,480 tons of this class of ore were produced (from 14 mines). In the neighborhood of 75,000 tons of this was used in the local forges, after undergoing concentration by burning, crushing, and jigging.

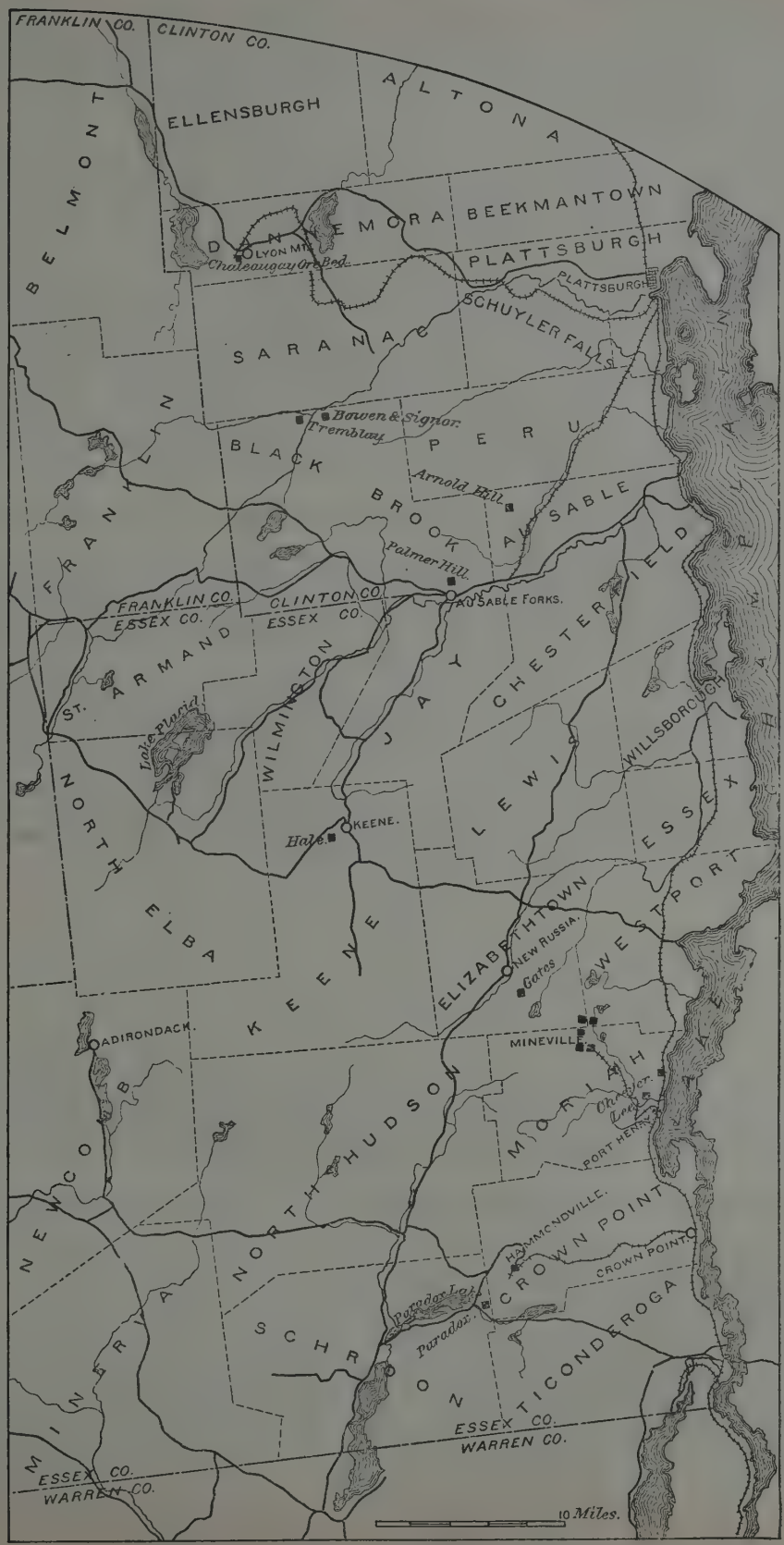


Fig. 24.—Map of the Lake Champlain Iron Region.

a Only one deposit of pyritous ore—the Lee mine, near Port Henry—was worked in the census year.

No titaniferous ore was mined, as it has no commercial value at present. The region could undoubtedly supply a large amount of this class of ore should there ever be a demand for it. Besides the immense masses of it near the old village of Adirondack, described by Dr. Emmons, (*a*) there are other extensive deposits nearer the lake, in Westport township, and elsewhere.

In a paper on the Laurentian iron-ore deposits in northern New York, (*b*) Mr. Charles E. Hall states that the titaniferous ores belong to the Upper Laurentian (Labradorite) series, the magnetic ores of Mineville, etc., to the Lower Laurentian, while the relation of the sulphur-ore series he regards as still undetermined.

Phosphatic and non-phosphatic ores are both found in the Lower Laurentian series. At Mineville, however, where they occur near each other, they are seen to occupy different horizons, the phosphatic ore being below the
b ore free from phosphorus.

The most important group of mines in the Lake Champlain region is that near Mineville, Moriah township, Essex county. In speaking of this group, Mr. Hall says: (*c*) "The mines at Mineville, in the township of Moriah, are located about 1,200 feet above the lake level, which is about 100 feet above the level of the sea. These mines are located on two distinct horizons. The beds located on the upper horizon are the *New Bed*, *Barton Hill*, and *Fisher Hill* mines. Those of the lower horizon are 21, the *Old Bed*, and *Cook's Shaft* mines. The general pitch (*d*) of the ore is to the west and northwest where the structure has not been complicated by faults. It is, in many cases, scarcely possible to determine the direction in which the beds pitch, but from all I can learn from careful observation, the deposits at the lower horizon, or those of 21 and the *Old Bed* mines, are on a line of an anticlinal fold, which has been complicated by faults.

c "At the *Cook Shaft* we have clearly a monoclinal, pitching to the westward, as we have in the upper workings of the *New Bed*, *Barton Hill*, and *Fisher Hill* mines."

The accompanying maps and sections, from surveys by William H. Case, C. E., made in part for the owners (*e*) of the mines and in part for the United States Geological Survey, will doubtless prove an interesting contribution to the subject of the structure of these ore-bodies. Plate XXVI shows the entire group of mines, with the exception of some old workings (now abandoned) north of Fisher hill. Plate XXVII shows the Mine 21 and Old Bed mines and Fig. 25 the New Bed and Barton Hill mines on a larger scale.

As stated by Mr. Hall, and as shown in part on Fig. 25, the structure of the western ore-bed, that is of the mines on the upper horizon, is quite simple. At the New Bed and Fisher Hill mines there are two or three overlying beds or lenses of ore, while at the Barton Hill openings there is but one bed. The dip in all the openings is
d toward the west, and usually at an angle below 45°. The inclosing rock is gneiss. The ore from all parts of the upper horizon is alike in containing but little phosphorus. Its principal gangue is quartz. At the New Bed some of the ore consists of a mixture in nearly equal parts by volume of colorless quartz and grains of magnetite. The latter often has a splendent luster, and a specimen of the ore has a very beautiful appearance. The per cent. of iron and phosphorus in the ores from these mines is given below—

e

	No. 1193.	No. 1358.	No. 1196.	No. 1190.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	43.74	39.15	49.86	46.91
Phosphorus	0.002	0.019	0.048	0.030
Titanic acid	Absent.	Present.	Present.	Present.
Phosphorus in 100 parts iron	0.005	0.049	0.096	0.064

Sample No. 1193 is from 5,000 tons of New Bed ore. The sample was collected on the dock at Port Henry. Sample No. 1358 is from three car-loads of ore from the South Barton Hill mine. Sample No. 1196 is from 500 tons of ore from the Barton Hill openings on the hill. The sample was collected at the Bay State Iron Company's furnace. Sample No. 1190 is from 8,500 tons of Fisher Hill ore. The sample was collected on the dock at Port Henry.

The New Bed mine is operated by Witherbee, Sherman & Co. It produced in the census year 31,143 tons of ore.

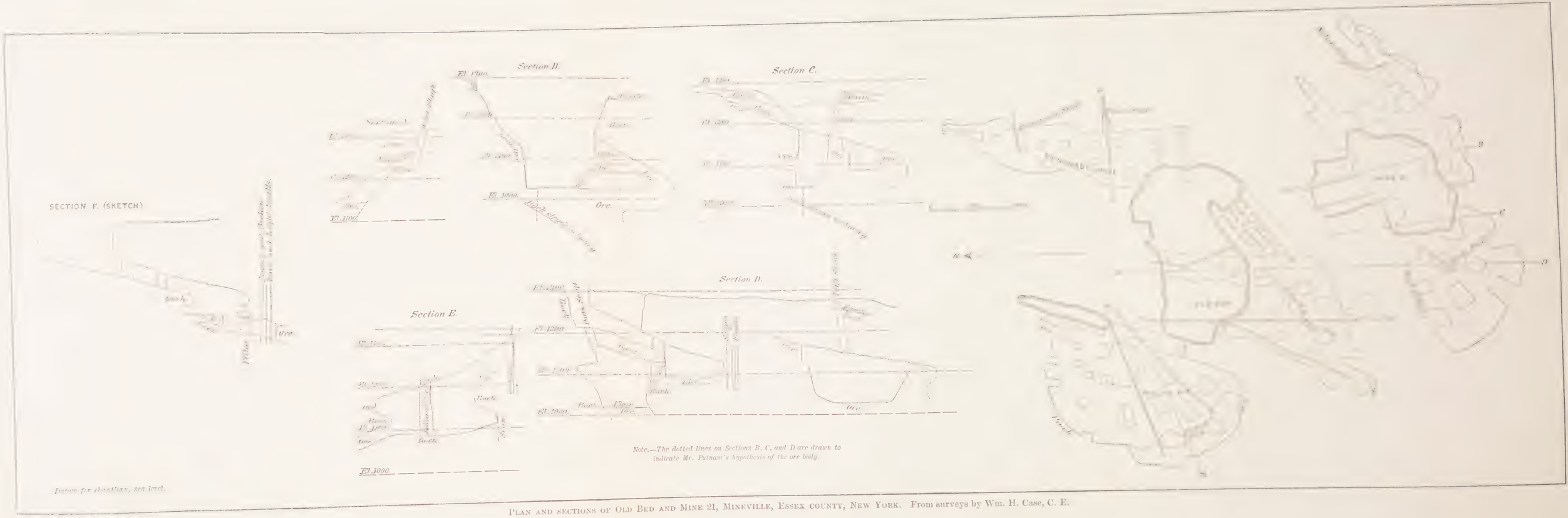
f *a Geology Second District*, p. 244, *et seq.* Dr. Emmons does not state that the Adirondack ores are titaniferous. But Prof. James Hall told me that they contained 10 per cent. of titanic acid.

b Reprinted from *Thirty-second Annual Report State Museum Natural History*, Albany, March, 1880.

c Loc. cit., p. 5.

d Mr. Hall has used the word *pitch* to describe what the New Jersey geologists would call the *dip*. The pitch (*i. e.*, the direction of the longer axis of the shoot, lens, or pod) is, in all of the above-mentioned cases, toward the *southwest*, obeying in this what appears to be a general rule for the magnetite deposits of New York and New Jersey, which may be stated thus: When the dip is towards the east the pitch is towards the north; when the dip is towards the west the pitch is towards the south. I know of but two or three exceptions to this rule.

e I am indebted to the Port Henry Iron Ore Company and to Messrs. Witherbee, Sherman & Co. for permission to use Mr. Case's notes of the surveys of these mines.



Plan and sections of Old Bed and Mine 21, Mineville, Essex county, New York. From surveys by Wm. H. Case, C. E.

The Barton Hill mines are worked by the Bay State Iron Company. They produced 11,559 tons of ore in the census year.

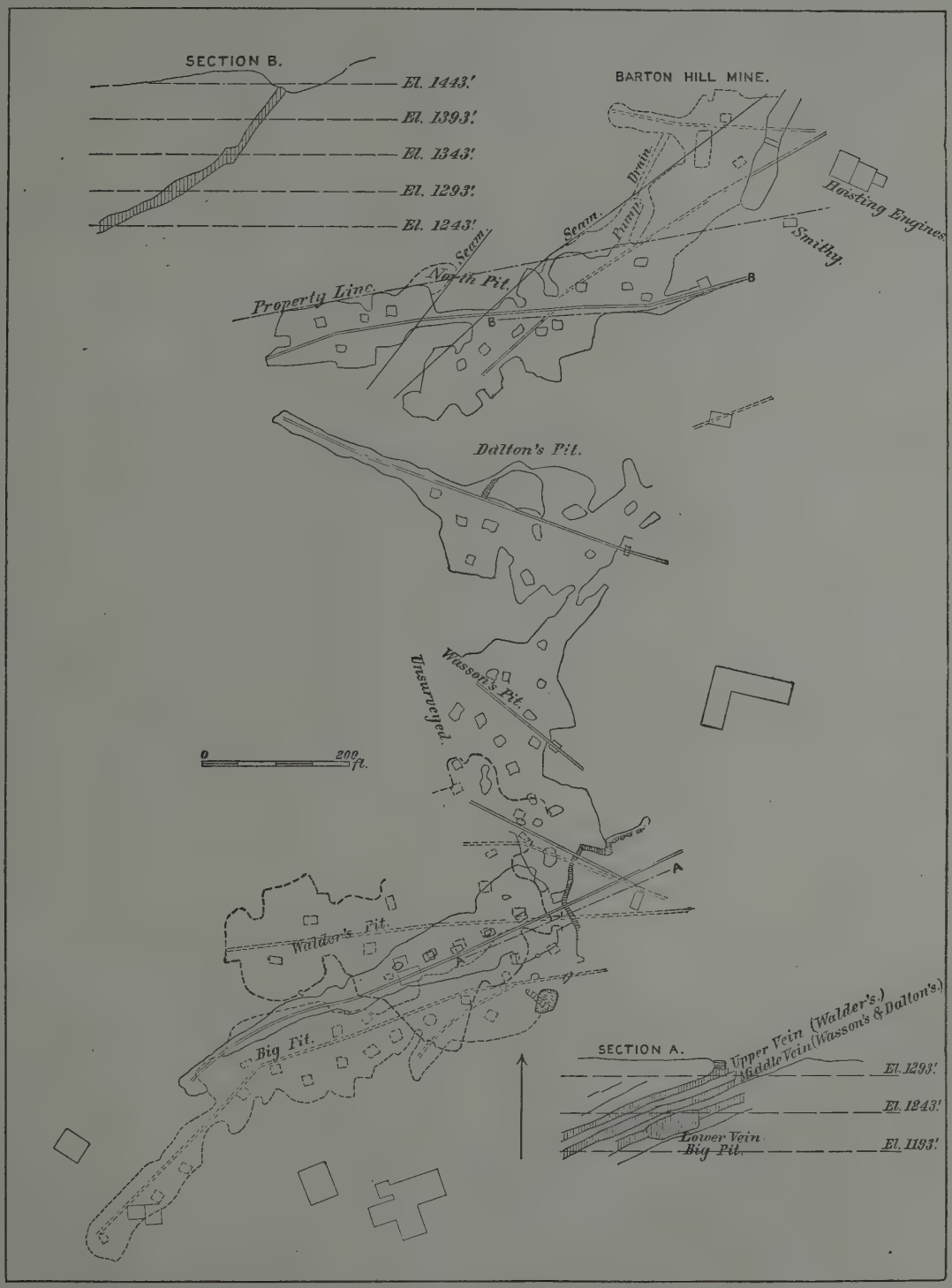


FIG. 25.—PLAN OF NEW BED AND BARTON HILL MINES, NEAR MINEVILLE, ESSEX COUNTY, NEW YORK. From surveys by Wm. H. Case, C. E.

The Fisher Hill mine is worked by the Port Henry Ore and Iron Company. It produced 10,378 tons of ore in the census year.

a Of the beds on the lower horizon, an examination of Plate XXVII will show how complicated is the structure of the group known as *Mine* 21 and *Old Bed* mines.

In the *Brinsmade* mine and *Miller* pit (see sections A and E) the ore dips to the westward, while in Old Bed and Mine 21 (including *Nolan* and *Tefft* shafts) the general dip near the surface is southward.

The *Brinsmade* mine is about 175 feet deep. The ore, which immediately beneath the surface material was about 19 feet thick, has increased, at the bottom of the Welch shaft, to 50 feet in thickness. Toward the north the dip becomes steeper than is shown on section A, and at the north end of the workings it is nearly vertical. From the south end of the mine, and near the roof, a drift has been driven (through rock) westward to the open pit of Old Bed.

In the *Miller* pit the ore has pinched out along the northern, northwestern, and western sides. In the southern
b part of the mine (and here the dip is toward the southwest) there is still a good breast of ore. A peculiar feature in this pit is the S-shaped fold in the walls, which resulted in a breast of ore 115 feet high at one point. This is shown on section E. The dotted line on the plan indicates the limit of the foot-wall fold. Between Miller pit and Old Bed the ground, as is shown in a drift between them and by an excavation westward from near the bottom of the Old Bed workings (which followed a tongue of ore), is much contorted and broken up by seams and faults. The ore-mass in Miller pit is somewhat lower than that in Old Bed. The original connection of these two ore-bodies seems, however, to be well established.

Old Bed was first worked as an open pit, and a large part of the hanging-wall has been taken down, so that the width of the ore at the outcrop cannot now be seen. The eastern half of the pit was worked by the Port Henry Ore and Iron Company and the western half by Witherbee, Sherman & Co.; the property-line is a meridian
c passing near Potts' shaft. The roof in the underground workings of the Port Henry Ore and Iron Company has fallen in. The workings were never surveyed, but the southern side of the pit is shown approximately by the dotted line. Along it there is said to be a breast of ore 7 to 10 feet high. The workings on Witherbee, Sherman & Co.'s property extend 175 to 300 feet beyond the southern edge of the open pit. Referring to the plan, the solid line about midway between the edge of the open pit and the southern end of the workings indicates where the foot-wall makes a sharp bend downward and forms an "S"-shaped fold, the ore following in under the rock, as in Miller pit (section E). The relation of the Potts' shaft ore-mass to the rest of Old Bed has, I believe, always been considered difficult to explain; but by carefully comparing sections D and F(*a*) I think an "S"-shaped fold, increasing toward the east, is at once suggested. Since the axes of the two portions of the fold are not parallel, the ore below the fold would necessarily have a different direction of strike and dip from the ore above the fold;
d and this we find to be the case in Potts' shaft, where the dip is toward the southeast (at an angle of about 80°). The bottom of the pit south of the edge of the foot-wall fold is covered with ore. Work was suspended in this part of the mine on account of the frequent fall of masses of rock from the roof above. At the west, however, a shaft was sunk in the floor through 30 feet of ore and a lower chamber then opened. The shape of this chamber is indicated by a dotted line. The sides are ore. A partial section through the chamber is shown at F. This part of the ore-bed corresponds, I think, in its relation to the S-shaped fold, to Potts' shaft. In working southward from Potts' shaft, the dip will, under this hypothesis, gradually flatten, and the direction of the strike will change to southwesterly. When the ore is all removed the workings will be continuous with this lower chamber. The floor at the eastern end of the old pit corresponds in like manner to the bottom of the upper fold in the hanging-wall ("*a*" in section F). The southern wall of the pit is produced by the upper fold, as is indicated
e in the sections. On the east the pit is bounded by a vertical wall 30 or 40 feet high. The Port Henry Ore and Iron Company's workings extend eastward from the top of this wall, which probably is the face of a fault.

Excepting in Potts' shaft, the only work being done in Old Bed, when visited in July, 1881, was in the extreme southwestern portion of the mine, at the end of the western slides, where there is a breast of ore 10 or 12 feet high. The fold appears to die out in a pillar of ore somewhere between this stope and the lower shaft.

Mine 21 is about 300 feet south of Old Bed. The workings consist of an open pit 250 feet deep, and at the bottom, about 250 feet across in an east and west direction and 150 feet in a north and south direction. The bottom of the pit is all ore. The north side is lean ore, but on the other three sides the workings have been carried in underneath a roof of gneiss. As in Old Bed this roof originally extended part of the way across what is now the open pit. At section B the vertical distance from the bottom of the pit to the rock roof is 130 feet, which is the
f height of one of the pillars. Near the north side of the pit a vertical drill-hole struck rock 60 feet below the pit's bottom. Should this prove to be the foot-wall, the normal thickness of the ore at this point would have been about 230 feet (see section B). East of the open pit the ore has been exploited in two levels. The boundary of the lower level is indicated on the plan by a dotted line. No foot-wall has been uncovered anywhere in the mine.

It appears to me quite probable that the great thickness of the ore in this mine is due to a fold in the walls similar to that in the Miller pit. I have indicated the supposed fold in the hanging-wall or roof on sections B, C, and D by a dotted line. The true position of this line is undeterminable at present (1881). A suggestion of such a fold was observed in the southwestern side of Tefft shaft pit, where the roof appears to be beginning to bend downward.

a Section F is a sketch merely. The main facts are correctly indicated, but in the details may be a slight error.

About 750 feet south of Mine 21 explorations with the diamond-drill discovered ore. One shaft has been sunk a to this ore and a second one has been started. The location of the shafts is shown on Plate XXVI. The eastern shaft reached the ore at a depth of 156 feet at an incline of 78°. The ore dips southward at about 10°, and has been explored by a drift 180 feet long driven southward from the bottom of the shaft. At the end of this drift the ore is about 9 feet thick, but it appears to be lean. The drift is very wet, and the ore is all more or less peroxidized. A sample of the ore from a pile of 75 tons at the top of the shaft contained—

	No. 1359.
	Per cent.
Metallic iron	52.58
Phosphorus	0.019
Phosphorus in 100 parts iron	0.036

b

With the exception of the above, and a narrow seam of compact ore in the surface-workings of Mine 21, the ores from the different pits of this group of mines are almost identical in appearance. They are coarse-grained, "shotty" ores, generally fragile (more than one-half of the shipping product is fine ore), and always largely mixed with granules of brownish-colored apatite. Mine 21 is said to have been first worked as an apatite mine. Samples of ore collected from the different pits contained—

c

	No. 1351.	No. 1353.	No. 1354.	No. 1355.	No. 1356.	No. 1357.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	57.71	61.39	60.54	61.53	62.64	61.92
Phosphorus	1.266	1.282	0.830	1.302	0.908	0.876
Titanic acid	Present.	Present.	Present.	Present.	Present.	Present.
Phosphorus in 100 parts iron	2.194	2.088	1.371	2.116	1.449	1.253

Sample No. 1351 is from the Brinsmade mine, south end (broken ore in stope); sample No. 1353 is from Nolan shaft (on cars at top of shaft); sample No. 1354 is from Miller pit (pile of ore at top of slope); sample No. 1355 is from Potts' shaft (pile of ore at top of slides); sample No. 1356 is from Old Bed, southwest side of pit (on cars and d pile of ore at top of slides); sample No. 1357 is from Tefft shaft (on cars at top of shaft).

East of section B, Mine 21, on the north side of the pit and near the surface, the stripping has been removed from a mass of partly-weathered ore which is now being mined. A sample was taken from a pile of 16,000 tons of this ore, on the dock at Port Henry. The sample contained—

	No 1189.
	Per cent.
Metallic iron	62.10
Phosphorus	1.198
Titanic acid	Present.
Phosphorus in 100 parts iron	1.928

e

The above ore is known as surface-ore. It is chiefly coarsely granular, but there are seams near the north wall of a compact ore which has a peculiar metallic luster. A separate sample was taken to represent this variety. The sample contained—

	No. 1358.
	Per cent.
Metallic iron	67.38
Phosphorus	0.465
Titanic acid	Present.
Phosphorus in 100 parts iron	0.689

f

Samples representing the shipping product of the pits worked by the Port Henry Ore and Iron Company, collectively known as "Mine 21", *i. e.*, Mine 21 proper, Nolan shaft, and Brinsmade mine, were taken from the large stock-piles at Port Henry.

(*Note.*—The "surface ore" is shipped separately and is not included in these samples.)

a The samples contained—

	No. 1187.	No. 1188.
	Per cent.	*Per cent.*
Metallic iron	61.39	62.66
Phosphorus	1.496	1.118
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	2.437	1.784

Sample No. 1187 is from 30,000 tons of lump-ore; sample No. 1188 is from 40,000 tons of fine ore.

b The shipments from "Mine 21" in the census year amounted to 187,448 tons.

The character of the ore shipped from the pits worked by Witherbee, Sherman & Co., which are collectively known as "Old Bed", *i. e.*, Old Bed, Potts' shaft, Miller pit, and Tefft shaft, is shown in the following analyses:

	No. 1191.	No. 1192.
	Per cent.	*Per cent.*
Metallic iron	61.46	63.01
Phosphorus	1.129	0.967
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.837	1.535

c

The samples were collected from the stock-piles at Port Henry. Sample No. 1191 is from 23,000 tons of lump-ore; sample No. 1192 is from 38,000 tons of fine ore.

In the census year 208,416 tons of ore were shipped from "Old Bed", and this, with the shipments from "Mine 21", makes a total of 395,864 tons of ore—all mined within an area 1,400 feet long by 1,000 feet wide. Such an amount of ore is not reported to have been produced elsewhere from so small an area of territory in one year. The total production of these mines is estimated at 3,784,000 tons.

Smith mine (formerly known as Cook's shaft) is located nearly a mile and a quarter due north from Old Bed. The ore lies in a single shoot which pitches toward the southwest at an average angle of about 30°. At the breast d the shoot is almost 140 feet wide. The ore is about 25 feet thick at the middle, but it thins down on either side. The approximate outline of the workings is shown on Plate XXVI. The mine is owned by H. T. Burler & Brother, and is worked by George B. Stimpson. In the census year it produced 16,800 tons of ore. The ore is like that in Old Bed and Mine 21. Samples collected on the dock at Port Henry contained—

	No. 1194.	No. 1195.
	Per cent.	*Per cent.*
Metallic iron	62.66	62.80
Phosphorus	0.946	0.870
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.510	1.385

e

Sample No. 1194 is from 200 tons of lump-ore; sample No. 1195 is from 3,000 tons of fine ore.

The *Cheever* ore-bed is situated about 2 miles north of the village of Port Henry, and about one-quarter of a mile from the shore of Lake Champlain. The outcrop of the ore was a little over 200 feet above the lake level. The mine is owned and operated by the Cheever Ore Bed Company. In the census year it produced 44,800 tons of ore.

The sketches on Fig. 26 will give a general idea of the shape of the ore-body. The longitudinal section and the cross-sections A B and E F were measured with a tape, and the levels were run with a lock-level and a light rod. The rod was read to 0.05 foot. While no great degree of accuracy was possible with this instrument, the errors are, it is believed, not appreciable on the scale of the sketch. The original plat was made on a scale of 100 feet to f the inch, and from this the sketch was reduced by pantograph. The plan of the mine was made from a few measurements only; it simply indicates the general outline of the pit. The workings, as I was informed by Mr. Presbrey, the superintendent of the mine, cover about 30 acres.

The original outcrop of the ore extended in nearly a straight line along a little depression in the hill S. 4° 45′ W. for 690 feet; then bending a few degrees to the east, it continued 150 feet in this new direction. The total length of outcrop was therefore nearly 850 feet. For a distance of 125 feet north of the bend there is only one bed of ore. At this point a second bed makes its appearance above the first. A section 140 feet from the bend is shown at G H, where the upper bed is 5 feet thick, the lower one 16 feet thick, and the two are separated by 19 feet of gneiss rock. Continuing northward the two beds approach each other, and the lower one becomes thinner. The dip at the surface also flattens, as is seen in section I J. A short distance north of this section the lower bed

thins out altogether. Between the sections G H and I J the lower bed is continuous, but the workings on the upper bed form, at the outcrop, two distinct pits separated by barren ground. Whether these pits are connected deeper down I did not ascertain. A section of the upper bed at I J was roughly measured as far down as the water.

Returning to the southern end of the outcrop, the following measurements are noted on the line of the main section, as the scale is too small to make them apparent on the sketch: At the outcrop the dip is 55°; the thickness of the ore was 13.8 feet. In descending, the dip gradually flattens, until at a vertical depth below the outcrop of 287 feet it is 35°. The distance between the walls down to this point varies from 10.2 to 14.2 feet. At the point marked "station 1" on the section, (*i. e.*, at the foot of the stairway) the bed flattens rapidly. The ore was here 19 feet thick.

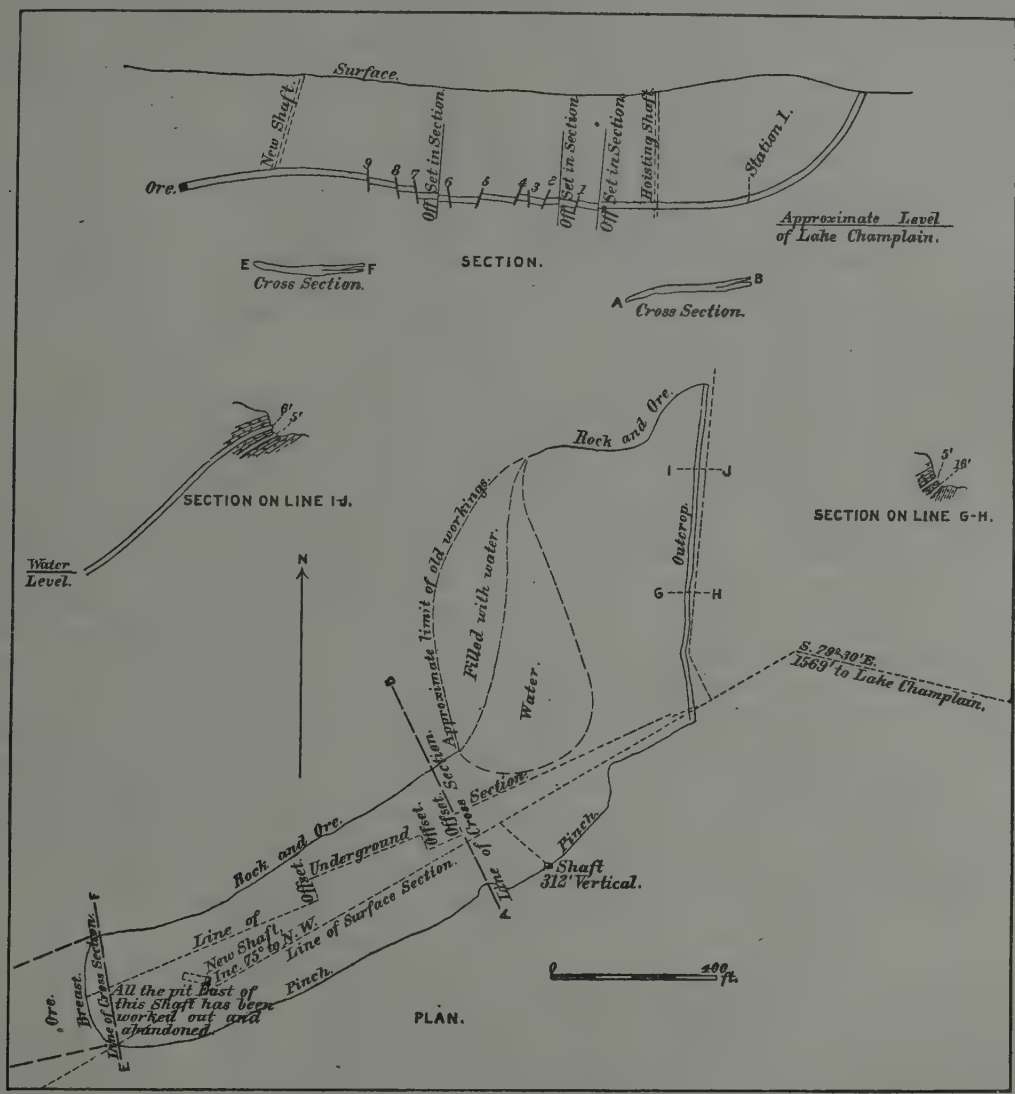


FIG. 26.—SKETCH OF THE CHEEVER ORE-BED, ESSEX COUNTY, NEW YORK.

NOTE.—The scale of the section is the same as that of the plan, and in the section the horizontal and vertical scales are equal.

Becoming nearly horizontal the walls approach to within 6.8 feet of each other 200 feet from station 1. Station 8, 345 feet from station 1, is over 300 feet vertically below the level of the outcrop and is the lowest point on the line of the section. It is not, however, as low as the bottom of the old shaft, as can be seen from the cross section A B. At 395 feet from station 1 an offset was made in the line to avoid a pillar, and at 445 feet from the same point the first fault is met with. The displacement at the section-line is 1.5 feet *downward*. The displacement increases toward the north and decreases toward the south. In the latter direction the line of fault bends around so as to have a nearly east and west course, crossing the cross-section A B, where the displacement is but a few inches. Another offset in the section-line was necessary 493 feet from station 1. Five hundred and eleven feet

a from station 1 a second fault occurs, with a downward displacement of 1.6 feet, and 42 feet beyond this a third, with an upward movement of 2.1 feet; 28 feet beyond the third fault is a fourth one, with a downward displacement of 4.5 feet. The fifth fault is 57 feet from the fourth and 691 feet from station 1. Here, also, the displacement is downward—31.1 feet. At the sixth fault, 762 feet from station 1, there is an upward displacement of 9 feet, and at the seventh a similar one of 13.5 feet. This latter is the greatest displacement anywhere observed. The fault extends across the pit in a general northwest and southeast direction, and entirely "cut out" the ore, the continuation of which was only found after much exploring; this fault is 840 feet from station 1. West of it are two others, Nos. 8 and 9, 888 feet and 961 feet from station 1, respectively. The displacement at No. 8 is 8.5 feet, and at No. 9, 8 feet. [The amount of displacement given is always on the line of the section. It sometimes b increases toward the north, sometimes toward the south, and occasionally dies out altogether; or the fault runs into another one forming a wedge-shaped piece of ground, which has been displaced to a more or less extent than the surrounding rock. Such a piece is seen between faults Nos. 2 and 3 and Nos. 5 and 6. A more marked instance is near fault No. 7, but south of the line of the section, where a triangular mass of ground has *sunk*. The amount of displacement here is not known, but it is greater than the thickness of the ore.]

Along the line of the section in the faulted region the ore varied in thickness from 7½ to 12½ feet.

The inclination of the face of the faults, or their *hade*, is indicated on the sketch, and it is seen to give in all cases the clue to the direction of the displacement. The faults are all normal. Although the faults are both upward and downward, the greater displacement, as well as the general inclination of the strata between the faults, is upward toward the west. Station 24, above fault No. 9, is 31 feet above station 1, and 48 feet above station 8, c the lowest point on the line. From fault No. 9 the ore-bed rises gradually for about 200 feet, to the bottom of the new shaft, where it is some 40 feet above station 1. From this point the ore pitches downward, so that the breast, 225 feet from the shaft, is 42 feet lower than the latter. The thickness of the ore along the section line between fault No. 9 and the breast varied from 8.8 to 11.7 feet.

From the old shaft to the breast the width of the ore-body varied but slightly. On the line of the section E F the width of the pit is 271 feet. The bed is here trough-shaped. From the outcrop to the breast the pit is bounded on the south by a pinch. Explorations south of this pinch have thus far failed to find ore. Near the middle of the breast, and about midway between the "roof" and the "floor", the bed of ore is divided by a thin seam of feldspathic rock, which gradually increases in thickness toward the north, and finally almost entirely replaces the ore. Mining is stopped in a northward direction as soon as the limit of profitable working is reached. There are d two seams of ore, one near the floor and one near the roof, all along the north wall of the pit. I understand that explorations have never been carried northward to the point where the ore entirely disappeared.

Along the outcrop, the rock near the ore is a hornblendic gneiss, often with part of the hornblende replaced with magnetite. The new shaft passed through garnetiferous gneiss, white crystalline limestone, hornblendic gneiss, and micaceous gneiss. About a quarter of a mile north of the mine is a quarry of white limestone with serpentine. A layer of serpentine schist was observed on the face of fault No. 7, in the mine.

The ore is all coarsely granular, and contains brownish grains of apatite. It is similar in every respect to the ore from Old Bed and Mine 21. To determine if the per cent. of phosphorus varied in the different parts of the bed, four samples were taken from the breast. Sample No. 1181 is from near the south wall; the chippings were taken from the roof to the floor. Sample No. 1182 is from the middle of the breast—from the floor to the seam of e rock. Sample No. 1183 is also from the middle of the breast, but it is from the upper part of the bed—from the seam of rock to the roof. Sample No. 1184 is from near the north wall—from roof to floor (exclusive of the rock seam). Before the samples were ground they were emptied onto a sheet of paper and the numerous chippings were carefully examined. Not a single chip was found without apatite. The samples contained—

	No. 1181.	No. 1182.	No. 1183.	No. 1184.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	65.33	63.50	63.86	64.42
Phosphorus	0.643	0.603	0.689	0.452
Titanic acid	Present.	Absent.	Present.	Present.
Phosphorus in 100 parts iron	0.984	0.950	1.079	0.702

f About two-thirds of the ore comes from the mine as fine material. The large lumps are picked out and shipped separately, as they are usually considered more desirable for use in the furnace. Samples were taken from large piles of lump and fine ore on the dock, to represent the shipping product of the mine. These samples contained—

	No. 1185.	No. 1186.
	Per cent.	*Per cent.*
Metallic iron	64.77	63.08
Phosphorus	0.673	0.573
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.039	0.908

The lump ore is represented by sample No. 1185, and the fine ore by sample No. 1186.

The *Lee* mine is located on the hill north of the northern boundary of the village of Port Henry, and on the east side of the road between Port Henry and Mineville. The mine is owned by J. A. Lee, esq, and was last operated by Milo J. Jennings, recently deceased. In the census year 6,160 tons of ore were raised. In the neighborhood of 4,000 tons were stocked at the mine when visited; the mine was idle. The extent of the developments is shown in Fig. 27, on which the dotted lines on the plan indicate approximately the limits of the

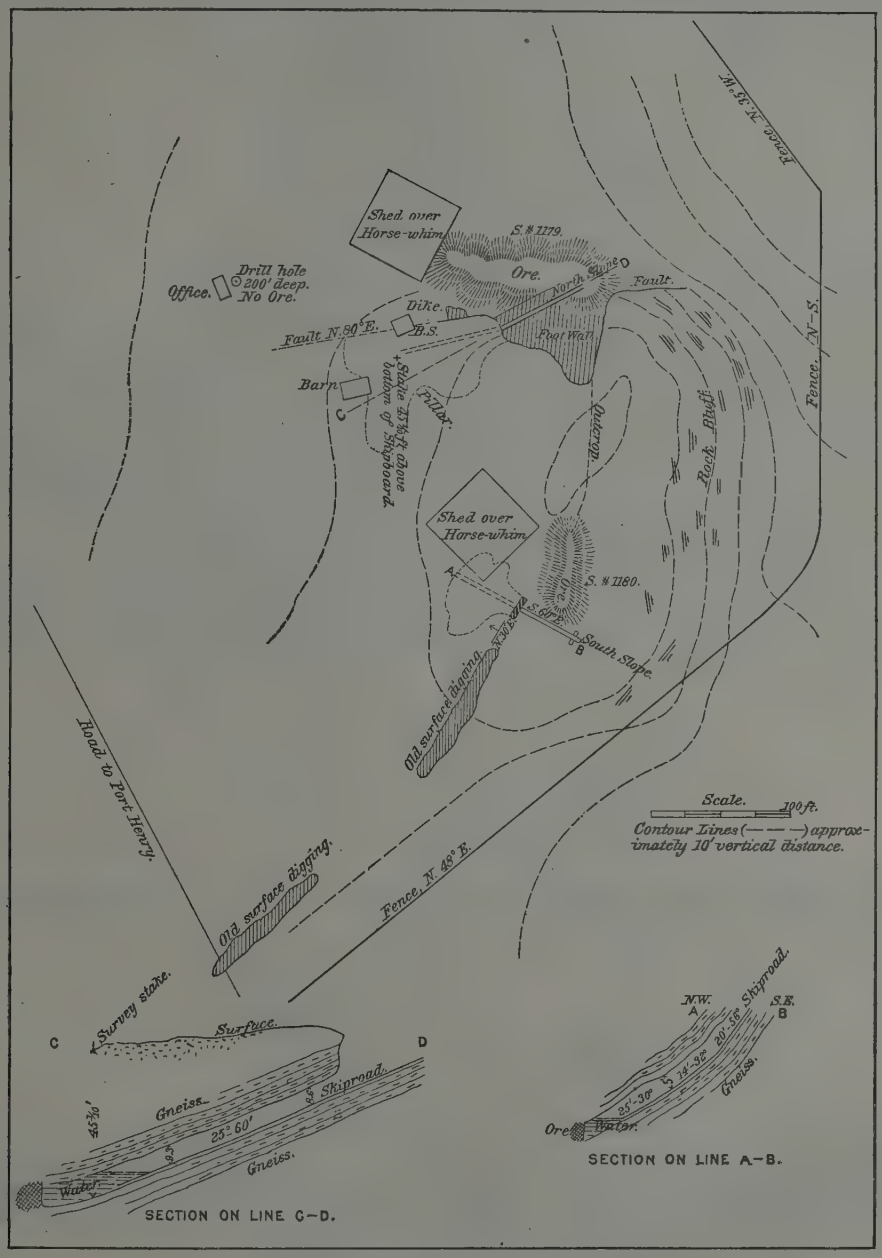


FIG. 27.—SKETCH OF THE LEE MINE, ESSEX COUNTY, NEW YORK.

underground workings. The ore is cut off on the north by a basaltic? dike, along the south side of which there has apparently been an upward movement of the country. The north side of the hill or knoll presents a vertical wall, which terminates at the east in a rocky bluff (a series of north-and-south faults?). Search has been made for the continuation of the ore by a diamond-drill hole near the office. I was told that this hole had penetrated to a depth of 200 feet without striking ore, and had then been abandoned. All the cores that I could find about the top of the hole were dike-rock. I could not learn whether other rock had been passed through. If not, the

a hole, of course, proved nothing excepting as to the *width* of the dike. The hole should have been located farther north. On the crest of the hill, near the north opening, the outcrop of the ore can be traced in a nearly southerly direction for about 100 feet. At the south slope the strike is south 30° west, indicating a change in direction of 30° in a distance of 25 feet. The point of actual bend is covered with a pile of ore. The old surface-workings near the road have a direction of south 40° west, and indicate, therefore, a further bend in the outcrop.

The ore is in the main finely granular and contains considerable pyrite. It would probably require roasting before it could be used in the blast-furnace. The per cent. of phosphorus and iron is shown below:

b

	No. 1179.	No. 1180.
	Per cent.	*Per cent.*
Metallic iron	45.01	44.38
Phosphorus	0.047	0.04
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.104	0.077

Sample No. 1179 is from 2,500 tons of ore from the north opening; sample No. 1180 is from 1,500 tons of ore from the south opening.

The *Crown Point* mines are situated at Hammondville, Crown Point township, Essex county, 13 miles west of the village of Crown Point. They are operated by the Crown Point Iron Company. In the census year 112,000 tons of ore were mined. A narrow-gauge railroad connects the mines with Lake Champlain. As is shown on Fig.
c 28, reduced from a map of the mines, the latter consist of 30 or 40 small openings, distributed over an area one mile and a quarter long by three-quarters of a mile wide. The topography of the district is mountainous, and the geology is complicated by numerous folds and faults. It would require very careful study to solve the many structural problems here presented. But from the facts observed I think it probable that the numerous beds belong practically to the same horizon, the repetition of outcrop being caused by several folds and faults. The dip in the eastern and western lines of openings is toward the east, but in the Penfield pit, between them, we clearly have an anticlinal fold, the western slope of which has been cut by a dike and faulted.

The ore from all the pits is very similar in appearance, and is, with the exception of the product of one or two pits, sufficiently free from phosphorus to be used for Bessemer steel. In pit No. 8, on Hammond hill, the ore recently mined contains apatite, although when the pit was first opened the ore was non-phosphatic. This pit was idle
d when the locality was visited, but a sample was collected from a pile of 7,000 tons of the ore raised during the past winter. This sample contained—

	No. 1348.
	Per cent.
Metallic iron	50.73
Phosphorus	0.090
Titanic acid	Present.
Phosphorus in 100 parts iron	0.177

e A sample of the general shipping product of these mines, exclusive of pit No. 8, was taken from a pile of 3,000 tons of ore on the dock at Crown Point. The sample contained—

	No. 1349.
	Per cent.
Metallic iron	49.09
Phosphorus	0.029
Titanic acid	Present.
Phosphorus in 100 parts iron	0.059

The ore is a mixture of magnetite, quartz, hornblende, and feldspar. A portion of it contains too little
f magnetite for furnace use, and this is sent to Irondale (about 6 miles from the mines, toward Crown Point), where it is used in the company's forges, after being "separated" in the usual manner. A sample of the separated ore contained—

	No. 1347.
	Per cent.
Metallic iron	63.30
Phosphorus	0.030
Titanic acid	Present.
Phosphorus in 100 parts iron	0.047

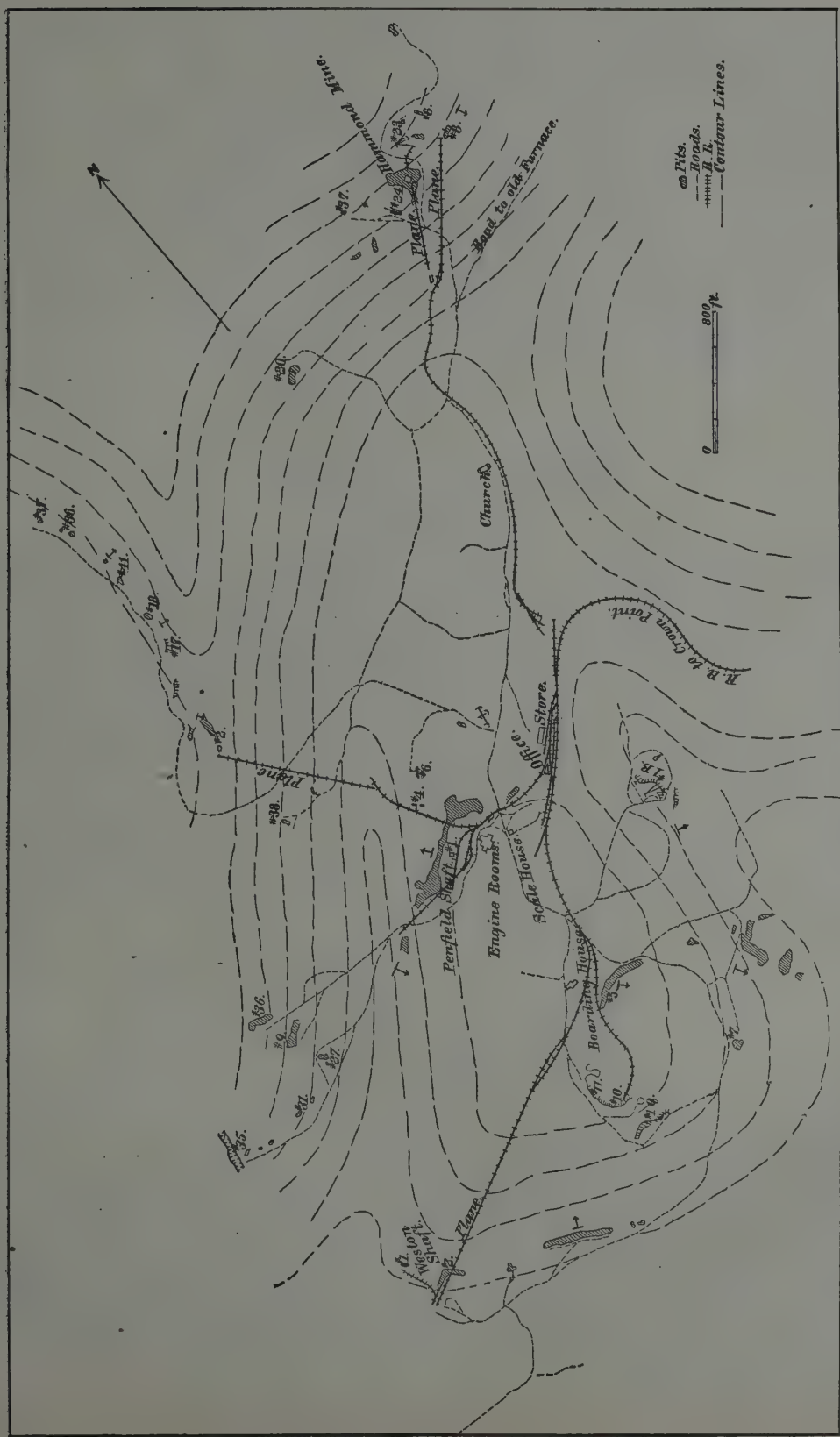


Fig. 28.—Map of the Crown Point Iron Company's mines at Hammondville, Essex county, New York. From surveys by William H. Case, C. E. The contour lines indicate approximately the surface features.

a Southwest of Hammondville, in Schroon township, near Paradox lake, two small mines were worked in the census year, and together produced 560 tons of ore. The ore was used in forges at Ticonderoga and at Schroon river. The mines were not visited and the ore was not sampled.

The *Gate's* or *Putnam* mine is situated in Elizabethtown township, northwest of Lincoln pond, and about 1 mile southeast of the village of New Russia. It is on Gate's farm, but the mine itself has recently been bought by Herbert A. Putnam, and is worked by him for the supply of his forge at New Russia. The existence of a vein of ore here has long been known, and about twelve years ago the Bay State Iron Company opened a mine some 50 rods north of the present workings. Their pit is reported to be between 200 and 300 feet deep (measured on the dip). It is now full of water. Work on the Putnam mine was begun in January, 1880. In May, 1881, the pit was about b 100 feet deep, measured on the foot-wall, which dips 57° to the west, and at the bottom 60 feet long. The ore varies in thickness from 18 inches along the sides of the pit to 4 feet in the middle. It will average, perhaps, 30 inches. The direction of the outcrop is a few degrees west of north.

A part of the ore is coarsely granular and contains granules of apatite. Before it is used in the forge it is concentrated in the usual manner. Sample No. 1197 represents the ore as it comes from the mine, and sample No. 1198 the separated ore. The samples contained—

c

	No. 1197.	No. 1198.
	Per cent.	*Per cent.*
Metallic iron	43.21	64.14
Phosphorus	0.456	0.136
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.055	0.212

It takes about 2 tons of "primitive" ore to make 1 ton of separated ore.

The *Hale* mine is located on Long Pond mountain, about 1 mile southwest of the village of Keene, Keene township. It is worked by W. F. and S. H. Weston. The ore lies in white crystalline limestone. The first opening made in the vicinity is on the Wood farm, which adjoins the Hale farm on the west. The Wood mine was opened by the Westons in 1872, and was abandoned in December, 1880. It produced 1,120 tons of ore in the census year. The ore formed a shoot 8 to 16 feet wide, which dipped at a high angle to the northwest and pitched to the northeast at an average angle of 45°. The pit is said to be between 250 and 300 feet deep (measured on the bottom-d rock of the shoot). Crystalline limestone surrounded the ore on all sides and was intimately mixed with it. From specimens seen limestone appeared to form the chief gangue. The Hale mine was opened in the spring of 1880. A shaft was sunk 40 feet through surface material, and entered what appears to be a large body of ore lying nearly horizontally in the limestone. A chamber 51 feet square has been excavated. On the east the ore pinches out; on the west it is cut by a dike, which forms the west wall of the pit; on the north there is a breast of ore 8 to 10 feet high. In places the room is 16 feet high, with ore still on the floor. Lying in the ore are, however, layers of limestone of various thicknesses, so that this height does not represent the thickness of good ore. Not enough work has yet been done to determine definitely the shape of the ore-body; but the probabilities are that the chamber is on the top of a shoot of ore which pitches to the northward, as in the Wood mine. Samples of the ore as it comes from the mine and after concentration contained—

e

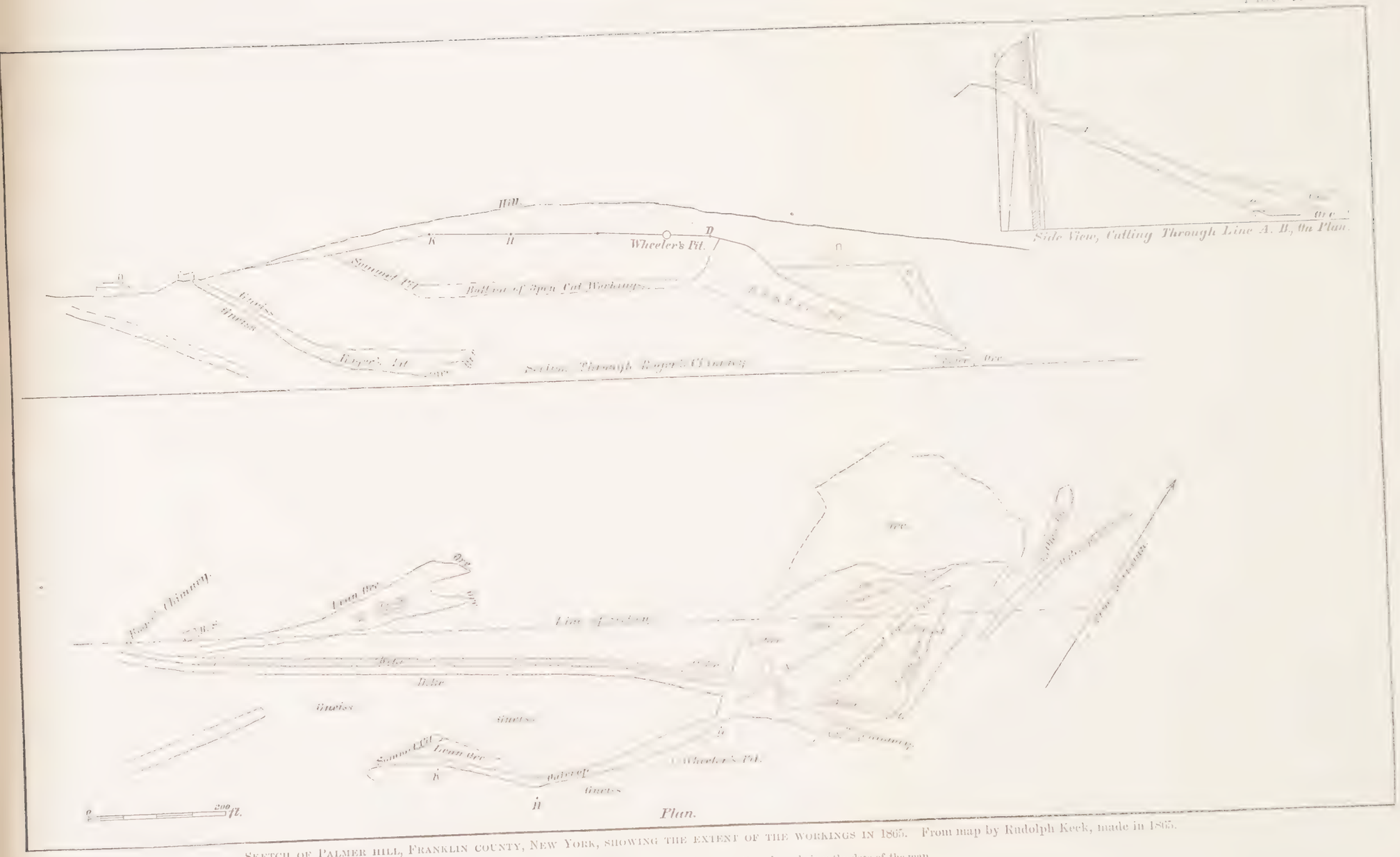
	No. 1199.	No. 1200.
	Per cent.	*Per cent.*
Metallic iron	49.37	59.92
Phosphorus	Absent.	0.002
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.000	0.003

Sample No. 1199 is from 50 tons of "primitive" ore. Sample No. 1200 is from 100 tons of "separated" ore.

The chief gangue of the ore is calcite. Pyrite seems to be absent.

Palmer Hill is one mile and a half north of the village of Ausable Forks, Black Brook township, Clinton f county. In it there are two large shoots of ore. The western shoot is worked by the J. J. Rogers Iron Company and the eastern one by the Peru Steel and Iron Company. Plate XXVIII shows a sketch of the workings, reduced from a plan in the office of the Peru Steel and Iron Company, which I was permitted to copy. The survey was made in 1865, and since that date the Rogers pit has been considerably deepened, and Little pit, east of the Peru Steel and Iron Company's main pit, has been excavated. This latter is in a small shoot of ore parallel to, but apparently distinct from, the main body. It is connected with the large pit by a rock drift. The bottom of the large pit is filled with water, and the only work being done in it, in June, 1881, was the removal of a large pillar of lean ore. A little ore was being mined in the cut at the entrance to the main pit north of the engine-house; but the greater part of the ore came from the Little pit.

The original workings were in an open cut along the outcrop. At a depth of about 75 feet, however, the ore



SKETCH OF PALMER HILL, FRANKLIN COUNTY, NEW YORK, SHOWING THE EXTENT OF THE WORKINGS IN 1865. From map by Rudolph Keck, made in 1865.

NOTE.—Roger's pit and Little's pit have been greatly enlarged since the date of the map.

practically pinched out, excepting at the eastern end, where the "vein" was cut by a dike. This dike is about 14 a
feet thick and can readily be traced over the hill. Several smaller dikes occur near the main ore; two of these are represented on the sketch. The mine was described by Dr. Emmons on pages 299 and 300 of the *Geology of the Second District*, with a diagram on page 299. Roger's pit was not opened at the date of Dr. Emmons' report.

The character of the ore from the hill is indicated by the following partial analyses:

	No. 1301.	No. 1302.	No. 1303.	No. 1304.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	44.94	66.03	33.52	63.45
Phosphorus	0.023	0.007	0.000	0.002
Phosphorus in 100 parts iron	0.053	0.010	0.000	0.003

b

Sample No. 1301 is from 6,000 tons "primitive" ore from Rogers's pit; sample No. 1302 is from 7,500 tons "separated" ore from Rogers's pit; sample No. 1303 is from 500 tons "primitive" ore, and sample No. 1304 is from 1,000 tons "separated" ore from the Peru Steel and Iron Company's pit.

The ore as it comes from the mines is a more or less intimate mixture of magnetite, feldspar, quartz, and hornblende? (or chlorite?). A portion of the ore from the Rogers pit consists almost entirely of magnetite and flesh-colored feldspar, while part of it contains a considerable quantity of a soft, greenish mineral. The two varieties differ greatly in color. No pyrite nor apatite was noticed in the ore. The ore is all used in the local forges, and the iron is made into cast-steel. In the census year the J. & J. Rogers Iron Company raised 28,000 tons of ore, and the Peru Steel and Iron Company 8,670 tons. c

The *Arnold Hill* mine is about 5 miles northeast of Palmer hill, 3½ miles northwest of Clintonville, and 1½ mile west from Ferrona station on the Ausable Branch railroad; it is in Ausable township. The mine is an old one, and Dr. Emmons devotes several pages to its description. It was worked from 1864 (previous to which year it had been idle for some time) to 1881 by the Hussey & Howe Mining Company. Recently it has been bought by John A. Glidden, of Cleveland, Ohio, and is henceforth to be operated by a company under the name of the Arnold Iron Ore Company.

Seven parallel "veins" of ore have been opened upon the hill. But only three have recently been wrought. They are known as the Gray (or New Blue), the Black, and the Old Blue. These three veins are worked through one shaft. The distance from the Gray to the Old Blue varies from 65 to 80 feet; the Black is between the other two, and sometimes approaches one and sometimes the other. The Gray vein has been worked for a continuous d
length of 1,700 feet, and to a depth in some places of 400 feet. The Nelson Bush mine, a recent opening on the Gray vein, is 1,800 feet beyond the northeast end of the Arnold mine, and I am told there is a strong magnetic attraction between the two pits. The strike is north 23° east, and the dip at the Arnold shaft, which is on the Black vein, is, at the surface, 71° (to the northwest); it flattens to 60° at a depth of 184 feet and to 55° at a depth of 325 feet. In width the Gray vein varies from 3 to 25 feet, exhibiting the pinch and shoot structure so common in the New Jersey mines. The line of pinch pitches at about 40° to the northeast. The Black and Old Blue veins vary in width from 3 to 7 feet. In entering the mine one is at once struck with the evenness of the walls, from which the ore separates perfectly, except, perhaps, in the "swells" in the Gray vein. The wall-rock consists usually of alternate layers of magnetite and quartz and feldspar. The magnetite layers are parallel and of various thicknesses. A hand-specimen will often represent in miniature the structure of the large deposits. Dr. Emmons e
states that the "veins" are embraced in a deep-red granite. The pits described by Dr. Emmons have been abandoned, and at the present workings, so far as I observed, the walls were only occasionally granitic. The rock of the hill is mainly gneiss. The veins of ore are cut by several dikes and often slightly faulted. The ore is peculiar. In the Gray "vein" it is a granular magnetite, often "shotty", and of a black color. A hand-specimen will deflect the compass needle. Feldspar forms an essential part of the gangue; near the outcrop this was partially decomposed, giving to the ore a mottled or grayish aspect; hence the name. The ore from the Old Blue vein is a more or less coarsely granular *blue* hematite or martite; it gives a reddish-brown streak. Only the smallest pieces are lifted by the magnet, and a hand-specimen has no appreciable affect on the compass needle. The ore from the Black vein now being mined has also a blue color; but it is described by Dr. Emmons as being black. It is often coarsely granular (shotty), and the grains are readily taken up by the magnet. A hand-specimen when held near the compass deflected the needle a few degrees. The ore from both the Old Blue and the Black veins is f
usually quite soft. Samples of the ores from the three veins contained—

	No. 1305.	No. 1306.	No. 1307.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	59.92	61.28	62.84
Phosphorus	0.079	0.113	0.012
Titanic acid	Absent.	Absent.	Absent.
Phosphorus in 100 parts iron	0.131	0.184	0.019

a Sample No. 1305 is from the stope in the Gray vein, second level (325 feet from surface), 300 feet north of shaft. Sample No. 1306 is from the Black vein, third level (440 feet below surface), 200 feet north of shaft. Sample No. 1307 is from Old Blue vein, second level, 400 feet south of shaft.

All the fine ore from the Gray vein, and the "dirty" portion of the fine ore from the other two veins, is separated in the usual manner, excepting that it is not previously calcined. A sample of 2,000 tons of separated ore contained—

b

	No. 1312.
	Per cent.
Metallic iron	63.96
Phosphorus	0.107
Titanic acid	Present.
Phosphorus in 100 parts iron	0.167

Under the name of "chunk" the lumps of ore from the three veins, and much of the fine ore from the Old Blue and Black veins is shipped without treatment. Two samples were collected from a pile of 4,000 tons of "chunk" ore on the railroad dock at Ferrona. Sample No. 1310 represents the larger lumps and sample No. 1311 the fine material in this pile. The samples contained—

c

	No. 1310.	No. 1311.
	Per cent.	*Per cent.*
Metallic iron	62.05	60.87
Phosphorus	0.114	0.191
Titanic acid	Absent.	Present.
Phosphorus in 100 parts iron	0.184	0.314

The *Nelson Bush* mine, as has been already stated, is situated on Arnold hill, 1,800 feet north of the Arnold mine. It is now worked by the same company as is the Arnold mine. There are two openings. In the northern pit, 100 feet deep, the vein is 25 feet wide. In the southern opening it is narrower, owing to the pinch and shoot structure of the vein. The lumps of ore are shipped without treatment, but all the fine ore is separated. Samples d from piles of the separated and of the primitive ore contained—

	No. 1308.	No 1309.
	Per cent.	*Per cent.*
Metallic iron	61.62	54.60
Phosphorus	0.102	0.344
Titanic acid	Trace.	Present.
Phosphorus in 100 parts iron	0.165	0.630

Sample No. 1308 is from 300 tons of separated ore. Sample No. 1309 is from 1,500 tons of primitive (shipping or furnace) ore.

e In the census year the Arnold Hill mine was in operation but part of the time; it produced only 1,845 tons of ore. The Nelson Bush mine was not worked.

Bowen & Signor's mine is located in the village of Williamsburg, Black Brook township, near the Saranac river. The mine is an old one, and has been worked by the present owners since 1867. In the census year it produced 7,000 tons of ore. The vein strikes north 55° east and dips at a high angle to the southeast. At the first level of the mine, about 100 feet below surface, the vein has been worked for a length of 1,600 feet, and the ore has been taken out above this level save only enough to support the roof. The mine was worked underground from the start. The width of the workable body of ore at the first level averaged 20 feet, and in some places the pit is 30 feet wide. The ore is, however, all very lean and the walls are rough and irregular, although the pit as a whole is straight. At the southwest end of the mine ore is being raised from a second level, 75 feet below the first. The f ore is all used, after being concentrated, in Bowen & Signor's forges at Redford and Russia. It takes 2½ to 3 tons of primitive ore to make 1 ton of separated ore. Samples of the ore before and after treatment contained—

	No. 1313.	No. 1314.
	Per cent.	*Per cent.*
Metallic iron	34.28	66.78
Phosphorus	0.124	0.037
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.362	0.055

Sample No. 1313 is from 400 tons primitive ore; sample No. 1314 is from 100 tons separated ore.

Tremblay's mine is situated near the south bank of the Saranac river, 1½ miles west of Clayburgh. It is owned a and worked by Peter Tremblay. In the census year it produced 1,845 tons of ore, which was all used at Tremblay's forges at Clayburgh. The pit is 150 to 200 feet in length and 75 feet deep. The ore resembles that from Bowen & Signor's mine, except that it is leaner. The ore-mass is more irregular. Much rock is picked out at the surface, and it takes at least 3 tons of the ore as it is sent to the separator to make 1 ton of separated ore. Samples of the ore contained—

	No. 1315.	No. 1316.
	Per cent.	*Per cent.*
Metallic iron	28.62	65.01
Phosphorus	0.017	0.004
Titanic acid	Absent.	Present.
Phosphorus in 100 parts iron	0.059	0.006

b

Sample No. 1315 represents the burnt ore; it was taken from the crusher. Sample No. 1316 is from a pile of separated ore.

The *Chateaugay* mine is situated near Lyon Mountain station, between the Chazy and Upper Chateaugay lakes. Lyon Mountain station is 34 miles from Plattsburgh, via the Chateaugay and Dannemora railroad. It is 2,020 feet above the lake level. The existence of this deposit of ore has long been known, and it has been worked in a small way for the supply of local forges for some years, but it is only since the completion of the railroad (in 1879) that shipments to outside furnaces have been made. In the census year 44,800 tons of ore were raised. In c the spring of 1881 the Chateaugay Ore and Iron Company was organized; it took control May 1, and since then preparations have been made for extensive developments.

The deposit of ore is a very large one, and should there continue to be a demand for ores low in phosphorus, but containing less than 50 per cent. metallic iron, the mine may develop into one of the largest in the country. The extent of the workings in June, 1881, may be briefly stated as follows: The main pit is about 850 feet long at a depth of 50 or 60 feet, and 550 feet long at a depth of 250 feet (measured on the foot-wall, which here dips to the north at an angle of 45°). At the bottom of the pit the normal width of the ore is 12 to 15 feet. The walls are a feldspathic-quartz rock, containing more or less magnetite, and great masses of feldspar, hornblende, and quartz occur through the ore, which is itself only a more or less intimate mixture of magnetite with these minerals. Gneiss is nowhere uncovered in the mine, but at the surface it is seen to form the true walls of the d "vein". In the greater part of the main pit the strike of the ore is nearly east and west; near the eastern end, however, the direction changes to about north 60° east.

Plankey's (or Richardson's) shaft is 2,100 feet northeast from "Nolan's shaft" (the middle one of the three skipways in the main pit). It is 100 feet deep, 200 feet long, and 17 feet wide. The ore dips 70° to the northwest.

Brook pit is 800 feet northeast of Plankey's shaft; it is a small open cut.

Williams' shaft is 3,600 feet from Brook pit and 6,500 feet from Nolan's shaft. This shaft was filled with water when visited. It is said to be 100 feet deep. The dip at the surface is 69° (to the northwest), and the horizontal width at the bottom of the cribbing is 22 feet. Much of the rock on the dump is gray micaceous gneiss.

A pit has been opened about 1½ miles northeast of Williams' shaft, and apparently on the same vein.

Between Williams' and Nolan's shafts there is a continuous line of strong magnetic attraction, and a second e line south of the first is readily traced out. Near the bend, at the main pit, the attraction on the south vein is very strong, but the vein has nowhere been opened upon.

About 100 feet west of the main pit the Hammond pit is down to a depth of 30 or 40 feet, and several test pits have been sunk to the ledge, a short distance west of the Hammond pit. Beyond these there seems to be very little magnetic attraction.

The material from the mine is sorted into, first, rock; second, separating ore; third, shipping or furnace ore. The present output (June, 1881) is 48 to 54 car-loads (equal to about 300 tons) of shipping ore each 24 hours, and about an equal amount of separating ore. It takes about 3 tons of the latter to make 1 ton of separated ore. Samples of these ores contained—

f

	No. 1317.	No. 1318.	No. 1319.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	45.21	66.00	62.78
Phosphorus	0.011	0.003	0.103
Titanic acid	Absent.	Present.	Present.
Phosphorus in 100 parts iron	0.024	0.005	0.164

Sample No. 1317 is from 22 car-loads (about 120 tons) of furnace ore ready for shipment. Samples Nos. 1318 and 1319 are from 100 tons of separated ore at No. 2 separator, and 150 tons of separated ore at No. 3 separator, respectively.

a *Mine* 81, so called from the number of the lot on which it is situated, is owned and operated by the Chateaugay Ore and Iron Company. It is about a mile and a half west of Nolan's shaft, and seems to be on the same belt if not on the same vein of ore as the Chateaugay mine. There are two pits. The western pit is 100 feet deep, 226 feet long, and 16 to 19 feet wide. The strike of the ore is north 38° east, and its dip is 80° to the southeast. This pit was opened in the autumn of 1878. The eastern pit is 400 feet from the western one; it is 70 feet deep and 21 feet wide; it was opened in May, 1880. The ore is similar to the Chateaugay ore. It is teamed 1½ miles to the separator, and thence to the forges on the Saranac river. It takes fully 3 tons of primitive ore to make one ton of separated ore. The character of the ore is shown below:

b

	No. 1320.	No. 1321.
	Per cent.	*Per cent.*
Metallic iron	65.14	34.81
Phosphorus	0.017	0.041
Titanic acid	Present.	Absent.
Phosphorus in 100 parts iron	0.026	0.118

Sample No. 1320 is from 150 tons of separated ore. Sample No. 1321 is from 300 tons of primitive ore.

"81" completes the list of working mines in the Lake Champlain region.

Many other "veins" are mentioned by Dr. Emmons, both in Clinton and Essex counties, but for one reason or another they are not at present worked, and were therefore not sampled.

c

FRANKLIN AND SAINT LAWRENCE COUNTIES.

In Franklin county Dr. Emmons notes several localities where magnetic ore was being mined at the date of his report. These mines are now idle, however, and no ore was produced in the county in the census year. Magnetic ore is known to exist in the eastern part of Saint Lawrence county, but this district is still an almost unbroken wilderness, and little mining has yet been done. During the winter of 1880 some ore was raised near Jayville, in Fine township. (*a*) The locality was not visited, but a sample was collected from a pile of 500 tons of the ore at the Alpine furnace. The sample contained—

d

	No. 1345.
	Per cent.
Metallic iron	56.72
Phosphorus	0.009
Titanic acid	Absent.
Phosphorus in 100 parts iron	0.016

The ore is a rich-looking magnetite and contains no pyrite.

II. LIMONITES.

e

RICHMOND COUNTY (STATEN ISLAND).

Beds of limonite have long been worked in the northern part of Staten Island, in Middletown, Castleton, and Edgewater townships. All the deposits visited were underlaid with serpentine, and they are believed to be confined to the belt of this rock. Professor Mather says, in speaking of these deposits: (*b*) "The ore-beds, where I have seen them, are directly contiguous to the serpentine rock, which contains an abundance of carbonate and hydrate of magnesia, and which seems to have performed the same office in the deposition of the ore as the limestone-beds of Columbia and Dutchess counties."

In a paper on the "Geology of Richmond county", in the *School of Mines Quarterly* (New York, May, 1881), Mr. N. L. Britton, after stating that deposits of limonite are found resting directly on the "serpentine or talcose rocks", f remarks that these [the deposits of limonite] "have probably had their origin in the deposition of the material composing them from the waters of thermal springs, which have come to the surface through crevices in the serpentine; the iron in the solutions was probably in the form of carbonate, which on reaching the surface became oxidized by contact with the atmosphere, and was thrown out of solution and deposited as the hydrated sesquioxide as we now find it". Mr. Britton observed magnetic sand in one ore-bed on Todt hill, "which was probably washed in mechanically while the hydrated oxide was being deposited from solution."

The deposits are superficial, and their lateral extent is limited to a few hundred feet in any direction. They vary in thickness from a few inches to 12 feet or more, and, with the exception of those on Todt hill (New Dorp and Towle mines), which are east of the terminal moraine, the beds are covered with several feet of glacial drift.

a See Fig. 42, p. 141. *b* *Geology First District*, p. 489.

The ore occurs associated with yellow clay and yellow and red ocher. Analyses show the presence in the ore of over $1\frac{1}{2}$ per cent. of sesquioxide of chromium, besides small amounts of sulphide of nickel and cobalt. Its contents in phosphorus is, as a rule, comparatively low.

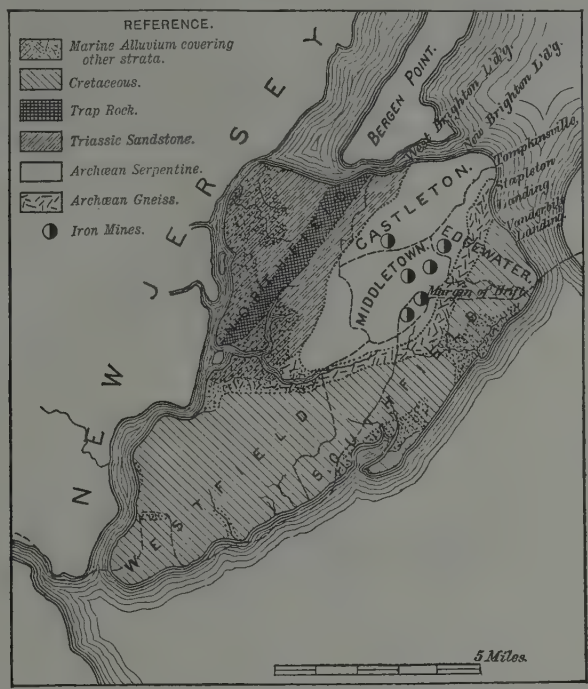


FIG. 29.—GEOLOGICAL MAP OF STATEN ISLAND. From map by N. L. Britton in *School of Mines Quarterly*, May, 1881.

Much of the ore is in small pieces and is separated from its gangue by washing. The larger lumps are picked out by hand. Besides the spongy-form or cavernous ore, common in all beds of limonite, there occurs in some of the

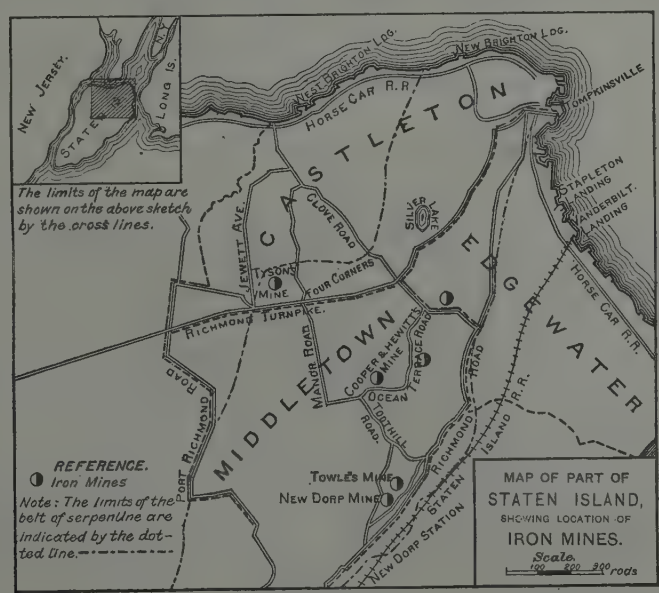


FIG. 30.

beds a peculiar oölitic ore, consisting of concentric spherical concretions of limonite imbedded in a ferruginous clayey matrix. The concretions vary from the size of a buckshot to that of a large "marble". The ore is locally known as "shot-ore".

The location of the beds worked in the census year is shown on Figs. 29 and 30.

a The *New Dorp* mine is situated on the east side of the Todt Hill road, in Middletown township, and about 1 mile north of New Dorp station, on the Staten Island railroad. The mine is near the top of a spur of Todt hill, perhaps 75 or 100 feet above the level of the road. The ore lies nearly horizontally, and is separated from the serpentine rock by a few inches of ocher. A breast of ore 4 or 5 feet thick is exposed along the north side of the pit. At the west end of this breast the ore is covered with but an inch or two of soil, but toward the east the surface material thickens (see sections on Fig. 31).

To the south and west of the pit the hill slopes quite abruptly and the ore appears to have been all removed by erosion; on the north and east the surface, however, is level or slightly rising, and in these directions the ore probably extends for some distance. The ore is washed in an inclined sluice-box. A sample taken from a pile of

b 3,000 tons of washed ore yielded on complete analysis—

c

	No. 714.
	Per cent.
Sulphur	0.391
Phosphorus	0.059
Iron, metallic	39.72
Silica	14.19
Iron, protoxide	6.55
Iron, peroxide	55.95
Alumina	8.59
Manganese, protoxide	0.52
Chromium sesquioxide	1.91
Lime	0.18
Magnesia	3.60
Iron, disulphide	0.293
Nickel, sulphide	0.55
Cobalt, sulphide	0.17
Potassa	0.19
Soda	0.40
Carbonic acid	0.22

	No. 714.
	Per cent.
Phosphoric acid	0.135
Carbon in carbonaceous matter	0.13
Hygroscopic water	2.21
Water of composition	10.20
Total	99.988
Insoluble silicious matter	21.26
Silica	14.19
Alumina (with a trace of oxide of iron)	3.47
Magnesia	2.92
Potassa	0.03
Soda	0.07
Phosphoric acid	0.01
Chromium, sesquioxide	0.68
Total	21.37

d Samples were also taken from a pile of about 100 tons of "rock-ore" which had been accumulating the same length of time as the 3,000 tons of washed ore. These samples contained—

e

	No. 712.	No. 713.
	Per cent.	*Per cent.*
Metallic iron	29.89	47.21
Phosphorus	0.107	0.043
Titanic acid	Present.	Present.
Manganese	.....	Present.
Phosphorus in 100 parts iron	0.358	0.091

Sample No. 712 consisted of chippings from selected pieces of "shot-ore"; sample No. 713 represents an average of the pile of rock-ore *exclusive* of the shot-ore, which latter formed but a small proportion of the pile.

The New Dorp mine is owned by S. B. Schieffeln. It was opened in March, 1880, but no ore was shipped before June. David Tyson, jr., is the operator.

Two hundred and fifty feet northeast of the mine above described is an opening about 75 feet long by 50 feet wide, from which 6,720 tons of ore were dug in the summer and autumn of 1879 by T. D. O'Brien. The mine is owned by Jeremiah Towle, and is designated the *Towle* mine on the map. Operations were suspended at the close of canal navigation, and the mine was idle when visited. The ore was not sampled, but a section of the bed at the north end of the pit is shown at E F, Fig. 31.

f *Tyson's Four Corners* mine is situated near the village of Four Corners, on the old Richmond turnpike. The mine is in the town of Castleton, and is about 2 miles by road from the dock at West Brighton. The old workings consisted of an open pit several hundred feet in length, which extended nearly to Jewett's avenue. This pit has been abandoned, and the present operations are south of the southeast end of it, under the apple orchard (see sketch, Fig. 32). Work was begun at this point in March, 1880. The ore is covered with 9 feet of clay and gravel, and after cutting a trench into the side of the hill for about 50 feet, exposing a breast of ore 6 feet in height on the west, a tunnel was started westward, and all subsequent mining has been done underground. The main drift is about 100 feet long, and is all in ore. From this other drifts have been driven at right-angles to it. The tops of

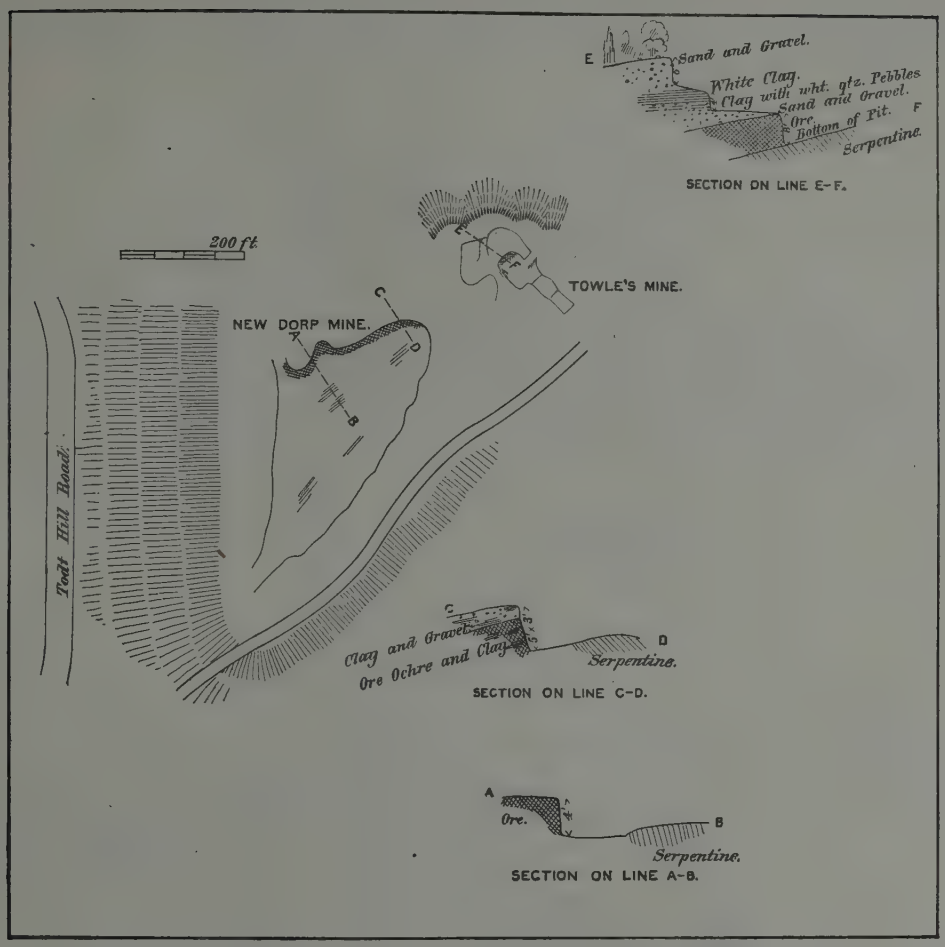


FIG. 31.—SKETCH OF THE NEW DORP AND TOWLE MINES, STATEN ISLAND, NEW YORK.

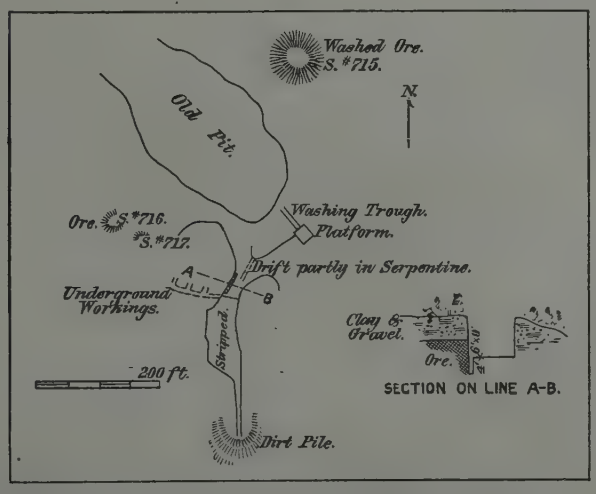


FIG. 32.—SKETCH OF TYSON'S MINE, FOUR CORNERS, STATEN ISLAND, NEW YORK.

a the drifts are cut in arch form, and scarcely any timbering is required. A trench along the west side of the cut is bottomed in ore, so that at this point the bed of ore is at least 10 feet thick (see section). The following analyses show the quality of the ore:

b

	No. 715.	No. 716.
	Per cent.	*Per cent.*
Metallic iron	48.74	41.64
Phosphorus	0.079	0.080
Manganese	Present.	.....
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.162	0.192

Sample No. 715 is from a pile of 500 tons of washed ore; sample No. 716 is from a pile of a few tons of rock ore, principally compact or cavernous limonite, but containing, also, a little "shot-ore".

Pockets of an almost black, earthy substance, called by the miner's "manganese", occur in the ore. Believing this to be more valuable than the iron ore, Mr. Tyson has had some of it placed in a separate pile. A sample taken from about 25 tons contained—

c

	No. 717.
	Per cent.
Metallic iron	51.20
Phosphorus	0.050
Metallic manganese	1.16
Chromium	Present.
Phosphorus in 100 parts iron	0.098

The analysis shows this material to be of no value except as an ore of iron.

Red and yellow ochers of apparently good quality are found here in sufficiently large quantities to be saved separately in mining.

d The mine is owned and operated by David Tyson, jr. About 200 tons of ore were raised between March and June, 1880. The mine was idle in 1879.

Cooper & Hewitt's mine is located near the Ocean Terrace road. The mine was idle when visited (August 6, 1881), but had been worked earlier in the summer; 1,344 tons of ore were raised from it in the census year. The size and shape of the pit is shown on the sketch (Fig. 33). The ore was screened instead of being washed. A sample from a pile of about 50 tons of screened ore contained—

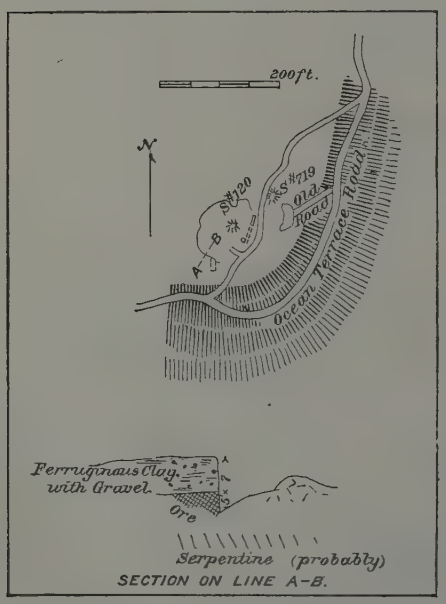


FIG. 33.—SKETCH OF COOPER & HEWITT'S MINE, STATEN ISLAND, NEW YORK.

e

	No. 719.
	Per cent.
Metallic iron	38.86
Phosphorus	0.022
Manganese	Present.
Phosphorus in 100 parts iron	0.057

If this ore was properly washed it would probably run 45 per cent. in metallic iron.

A sample was also taken here of a variety of compact, hard, and very dark-colored ore, which seems to occur in some quantities. The sample contained—

f

	No. 720.
	Per cent.
Metallic iron	51.57
Phosphorus	0.008
Manganese	Present.
Phosphorus in 100 parts iron	0.096

There are numerous old openings on the hill east of the above-mentioned pit, from which a large amount of ore has probably been taken. At one of these openings, about a half mile east of Cooper & Hewitt's mine, a little

ore was raised in the spring of 1880. When visited no work was being done and all the ore had been carted away. a The ore was screened. A sample of the fine screenings (refuse) contained—

	No. 718.
	Per cent.
Metallic iron	31.81
Phosphorus	0.048
Phosphorus in 100 parts iron	0.151

In Edgewater township, near the Clove road, some work was recently done at *Snell's* opening. The mine was b dle when visited and the ore was not sampled.

ORANGE COUNTY.

A deposit of limonite belonging to Vanduzer and Townsend, located in Cornwall township, was reopened in December, 1879, by Richard George. It was worked for four months and produced 672 tons of ore. This bed was described, under the name of the Canterbury ore-bed, by Professor Mather, (*a*) and it differs from the deposits in Dutchess and Columbia counties in being associated with the Helderberg limestone. Many fossils occur in the ore. The mine was not visited, but a sample was taken from a pile of 150 tons of the ore at the West Point furnace. It yielded on analysis— c

	No. 728.
	Per cent.
Metallic iron	28.57
Phosphorus	0.240
Manganese	Present.
Phosphorus in 100 parts iron	0.840

DUTCHESS AND COLUMBIA COUNTIES.

The belt of limonite ores east of the Hudson river extends from the southern part of Dutchess county d northward through Columbia county, New York, the northeastern part of Litchfield county, Connecticut, the western part of Berkshire county, Massachusetts, well into the state of Vermont.

The geological relations of these ore-deposits have recently been studied by Professor Dana in connection with the study of the "great limestone belt". Some of his conclusions may be briefly stated as follows: (*b*) Throughout the great limestone area the ore-beds are alike in the nature of the ore, its mode of aggregation, and its association with yellow ocher and clays. Manganese is generally present in the deposits, but is more abundant in the beds in Vermont than in those farther south. The beds occur in the vicinity of all the rocks of the limestone area—the limestone, hydromica slate, clay slate, mica-schist, gneiss, and quartzite. But they are most abundant where the schist is the hydromica slate. The deposits are "alike in their interrupted occurrence and varying depths—even many miles often intervening between those of workable value and all depths existing from zero to 150 feet or e more". The ore has been derived principally from the oxidation *in place* of carbonate of iron and ferriferous limestone, and to some extent, also, from the iron-bearing minerals of the schists which were near the iron carbonate. These schists have been changed to soft clay, probably largely through the destructive influence of the carbonic acid set free through the oxidation of the iron in the ferrous carbonate. Silicates, like garnet, black mica, and chlorite, would yield to the same agent, and so give up their iron for oxidation. Sulphuric acid would also have aided in the destruction wherever any pyrite existed. "But the nearly total absence from the ore of sulphur (seldom over one-tenth of one per cent.) appears to be evidence that pyrite played a very subordinate part in the production of the limonite."(*c*) "The beds all show that their formation was not dependent on erosion or transportation, and that the change to limonite required only the free access of air and moisture (with the traces of carbonic acid they ordinarily contain) to the iron-bearing minerals."

That surface drainage, in one way or another, played an important part in the production of these deposits of f ore is evident from the fact that all the large beds at least occur in valleys or on the sides of valleys. Professor Dana remarks: "From some of the mines it appears that the best positions for the making of deep beds was off the mouths of valleys or near slopes that carried down the rains for underground use." He adds: "An iron-bearing carbonate would suffer rapid destruction under these circumstances."

As bearing directly upon the question of the derivation of these ores, I may be permitted to point out that Professor Dana appears to be in error regarding their contents in sulphur. While the percentage of sulphur in

a Geology First District, p. 491.

b Geology of Vermont and Berkshire: Limonite ore-beds of the limestone region. *Amer. Jour.*, III, xiv (1877), p. 132.

c Loc. cit., p. 139.

a the ores is as a rule low, there are a number of localities where it is much greater than one-tenth of 1 per cent. For instance, in a paper on the Hematite Ore Mines and Blast-Furnaces East of the Hudson River, (*a*) Mr. James F. Lewis gives a table of analyses in which ore from the Amenia mine is credited with 0.34 per cent. sulphur; ore from the Manhattan mine with 0.69 per cent. sulphur; ore from the Riga mine with 0.68 per cent. sulphur, etc. It is to be regretted that time permitted the determination of sulphur in only a few of the samples collected for the census.

Commercially the ore in these mines is known as "wash-ore" and "rock-ore". By "wash-ore" is meant a mixture of small pieces of limonite, ocher, and clay, with sufficient of the former to pay for separating it from the other materials. The separation is effected by washing in inclined troughs or revolving cylindrical sieves.(*b*) The b latter method is the most thorough and is the one now usually employed. After washing, the ore is known as washed ore. By "rock-ore" is understood those pieces which can be picked out in mining and shipped without washing. The amount of rock-ore varies in the different beds, but it is usually (comparatively) small. At some mines all the ore is washed. The lumps of ore are generally cavernous or spongiform, but botryoidal, mammillary, and stalactitic varieties also occur, especially on the inner surface of "bombs". Many very beautiful speci- c mens are obtained from some of the mines, particularly from the Brookpit mine, in Salisbury, Connecticut, and the Manhattan mine, in Amenia, New York.

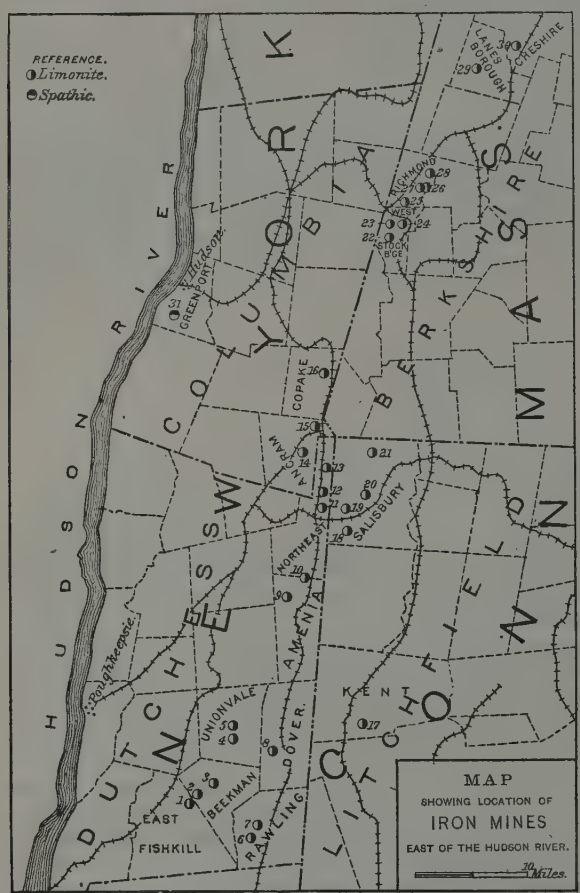


FIG. 34.

In New York and Connecticut the method of exploitation usually employed is by stripping the surface material (drift) from off the ore and digging the latter in open pits. In Massachusetts the open-cut mining has been nearly entirely superseded by underground work in shafts and levels.

DUTCHESS COUNTY.

d There are two belts of ore-beds in Dutchess county:

First. A belt extending along the valley of the Fishkill creek in a northeasterly direction from near the village of East Fishkill to the central part of Unionvale township.

Second. A belt extending along the valley through which runs the New York and Harlem railroad, from Pawling station, in the southeastern part of Dutchess county, to Hillsdale, in Columbia county. The direction of this belt is nearly due north and south.

e Outside the limits of the belts above described ore has been discovered on Stissing mountain, in Stanford township, and in Washington and Milan townships. No developments have been made, however, and the localities were not visited.

The location of the mines worked in the census year is shown on the map (Fig. 34).

FISHKILL CREEK BELT.

The ore-beds south and west of the village of East Fishkill have been long idle. In ascending the valley, the first working mine met with is the *Fishkill* mine (1).(*c*) This is located on the south shore of Sylvan lake, near Sylvan f Lake station, on the Clove branch of the Dutchess and Columbia railroad, 16 miles from Dutchess junction, the Hudson river terminus of the railroad. The mine is owned by Albert Tower, and is operated by the Poughkeepsie Iron Company; the ore is all used at Poughkeepsie; the pit is 90 feet deep; the ore is covered with an average of about 40 feet of surface material; no rock was seen in the mine, but Dr. Beck, (*d*) at the time of his visit (1837), found layers of decomposed slate alternating with the ore; limestone occurs west of the pit. From two-thirds to three-quarters of the material raised from the mine, exclusive of the "stripping", is shipped as ore. Very little rock-ore is found. A sample from 7 car-loads of washed ore yielded, on complete analysis—

a Trans. Amer. Min. Eng., *v* (1877), p. 235.
b The Thomas washer, so popular in Pennsylvania, is not used east of the Hudson river (1881).
c The numbers refer to the map, Fig. 34.
d Natural History of New York, iv, p. 492.

a

	No. 755.		No. 755.
	Per cent.		*Per cent.*
Sulphur	0.143	Phosphoric acid	0.167
Phosphorus	0.073	Carbon in carbonaceous matter	0.06
Iron, metallic	40.92	Hygroscopic water	0.87
Phosphorus in 100 parts iron	0.179	Water of composition	9.48
Silica	24.68	Total	100.317
Iron, protoxide	0.25		
Iron, peroxide	57.99	Per cent. of insoluble silicious matter	27.21
Alumina	3.82		
Manganese, protoxide	0.94	Silica	24.68
Lime	1.13	Alumina (with a trace of oxide of iron)	1.94
Magnesia	0.41	Lime	0.27
Iron, disulphide	0.270	Magnesia	0.23
Carbonic acid	0.25	Total	27.12

b

In the census year 18,346 tons of ore were raised from the mine.

Adjoining the Fishkill mine on the northeast, and really forming part of the same pit, is the *Sylvan Lake* mine (2), owned and worked by the Sylvan Lake Ore and Iron Company. Part of the ore is shipped to Burden & Sons, Troy, and the remainder is used at the Clove Valley furnaces. When smelted alone with charcoal the product is car-wheel iron. The pit is about 145 feet deep. The ore-bearing stratum is covered with 45 feet of "stripping". c Nearly the whole of the output passes through the washers, and about 50 per cent. of the material raised from the bottom of the pit goes to the mud-dam, although this varies greatly in the different parts of the bed. Sample No. 753 was collected from five car-loads of washed ore, and sample No. 754 from a pile of 40 tons of rock-ore. These samples contained—

	No. 753.	No. 754.
	Per cent.	*Per cent.*
Metallic iron	48.48	47.05
Phosphorus	0.050	0.041
Manganese	Present.	Present.
Phosphorus in 100 parts iron	0.104	0.087

d

In the census year 16,096 tons of ore were raised. The total product is estimated at 112,000 tons. The mine was opened in 1868.

West of the Fishkill and Sylvan Lake mines are two pits belonging to the Dutchess Ore Company, and known as the Horton mine. The mine was opened in 1872. It was idle during the census year.

Explorations made just north of the lake have recently discovered a bed of ore, but it has not as yet been developed.

The *Beekman* mine (3) is situated at Beekmanville, about 2 miles northeast of Sylvan lake, and one-eighth of a mile from the railroad. It is owned by Albert Tower, and is worked by the Poughkeepsie Iron Company. The e ore is shipped to Poughkeepsie. The pit is 65 feet deep. The stripping varies in thickness from 2 to 20 feet. Limestone outcrops a few rods northwest of the pit and in places forms the side of the pit itself. Usually, however, clay and ocher lie between the ore and the limestone. A little rock-ore is shipped from the mine, but the greater portion of the product is washed. Samples taken from a car-load of washed ore and a pile of a few tons of rock-ore yielded on partial analysis—

	No. 751.	No. 752.
	Per cent.	*Per cent.*
Metallic iron	29.50	51.85
Phosphorus	0.069	0.050
Manganese	Present.	Present.
Phosphorus in 100 parts iron	0.234	0.096

f

Sample No. 751 represents the washed ore, and sample No. 752 the rock-ore.

The low percentage of iron in sample No. 751 is to be accounted for from the fact that the ore had not been thoroughly washed, owing to a temporary scarcity of water.

In the census year the Beekman mine produced 7,364 tons of ore.

The *Clove* mine (4) is situated in the south-central part of Unionvale township, about 4 miles in a direct line northeast from Beekmanville, and 3 miles from the terminus of the Clove branch of the Dutchess and Columbia

a railroad. The mine is owned and worked by the Fallkill Iron Company. The ore is used in the company's furnaces at Poughkeepsie. The ore lies in limestone, which forms the eastern wall of the pit; it has been uncovered, too, at several points in the bottom of the pit. On the west no rock has yet been met with in the main pit; but in a small pit north of it (from which all the ore has been taken) limestone occurs on both walls. The main pit is about 600 feet long, and, in the northern end, where ore is now being dug, 90 feet deep. At this point 35 feet of stripping has to be removed. Very little rock-ore is obtained. A sample from 150 tons of washed ore contained—

b

	No. 758.
	Per cent.
Metallic iron	34.18
Phosphorus	0.049
Phosphorus in 100 parts iron	0.143

The ore was badly washed, owing to lack of water.

In the census year 4,516 tons of ore were produced.

A few rods northeast of the Clove mine is the *Clove Spring* mine (5), owned and operated by the "Clove Spring Iron Works". The ore is used at Clove Valley, making No. 1 and No. 2 foundery iron when mixed with Lake Champlain ores and smelted with anthracite, and car-wheel iron when smelted alone with charcoal. The present c stope is at the south end of the pit, at this point 56 feet deep. A section at the stope shows a breast of ore 33 feet 10 inches high on the east and 23 feet high on the west side of the pit, with the upper surface of the ore pitching to the west at an angle of 15°. Immediately overlying the ore is a bed of hard, blue clay 21 feet thick, near the western side of the pit, but thinning down against the ore toward the east. The upper surface of the clay is level. Above the clay is a mixture of horizontally stratified clay and gravel, the gravel gradually preponderating toward grass-roots. The surface slopes gradually to the west. Limestone forms the eastern wall of the pit. No rock was exposed on the western wall.

Of the material spoken of above as ore, about one-third is lost in washing. More rock-ore is found here than at any other mine on this belt, the proportion of rock to washed ore being about as 1 to 4. Samples were taken from piles of 350 tons of rock-ore and 500 tons of washed ore at the furnace. The samples contained—

d

	No. 756.	No. 757.
	Per cent.	*Per cent.*
Metallic iron	48.74	45.22
Phosphorus	0.083	0.128
Phosphorus in 100 parts iron	0.170	0.283

Sample No. 756 is the rock-ore; sample No. 757, the washed ore.

From July, 1871, to May 30, 1880, the mine produced 107,260 tons of ore. The output in the census year was e 19,400 tons.

NEW YORK AND HARLEM RAILROAD BELT.

The southernmost mine in this belt is the *Valley Pond* mine (6), situated in Pawling township, at the lower end of Little pond. The mine is owned by Stephen O. Davis and is operated by Cornelius J. Haight. Mining was begun in the spring of 1880, but no ore was raised before the close of the census year. Little pond is on the top of a ridge of highly metamorphosed garnetiferous and micaceous schists and gneisses,(*a*) and the ore-bed lies on a narrow valley or gulch extending south from the pond. It was first discovered about 400 feet from the pond. In August the bed had been uncovered by a trench 10 feet wide for a length of about 75 feet. Both sides of this trench are ore; the width of the deposit had not been determined. At the southern end of the trench there is about 6 feet of gravel and clay above the ore. Sample No. 749 was taken from 25 tons of washed ore and sample f No. 750 from 50 tons of rock-ore. The samples contained—

	No. 749.	No. 750.
	Per cent.	*Per cent.*
Metallic iron	48.93	48.70
Phosphorus	0.163	0.158
Phosphorus in 100 parts iron	0.337	0.324

a "Taconic". Dana, *Am. Journ.*, III, XVII, p. 485.

The *Pawling* mine (7), also in Pawling township, is located at the foot of the mountain, 2 miles west of Pawling station, on the Harlem railroad. It is owned by the "National Mining Company of Pawling" and B. A. Sill, and is worked by the company. In the census year 7,280 tons of ore were mined. The pit is about 400 feet long, 50 feet wide, and 45 feet deep (see Fig. 35). On the west side of the pit is a ridge of micaceous gneiss,(*a*) which dips to the east at an angle of about 60°. The east side shows 25 feet of ore, overlaid by 20 feet of clay and gravel. The bottom of the pit is ore. The ore pitches eastward underneath a swamp. Beyond the swamp there is a limestone

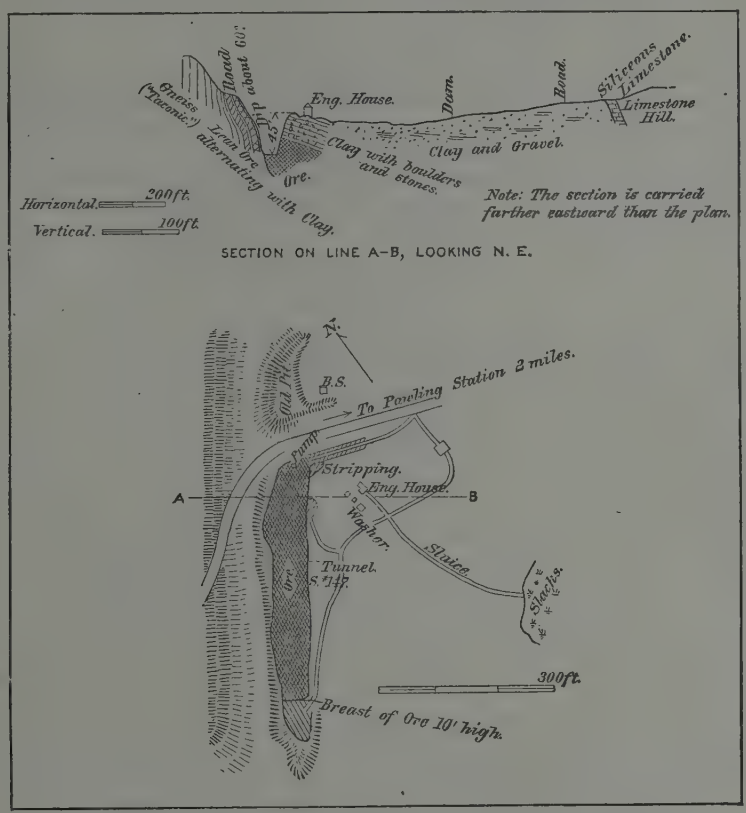


FIG. 35.—SKETCH OF THE PAWLING MINE, DUTCHESS COUNTY, NEW YORK.

ridge. Two samples of ore were collected from the mine. Sample No. 747 was taken from the sides of a drift about 20 feet long, which had been driven eastward from the bottom of the pit. Sample No. 748 is from a car-load of washed ore. The samples contained—

	No. 747.	No. 748.
	Per cent.	*Per cent.*
Metallic iron	43.22	47.12
Phosphorus	0.113	0.137
Phosphorus in 100 parts iron	0.261	0.291

The *Dover* mine (also known as the "White" or "Foss" mine) (8), is in Dover township, about 1½ miles from Dover furnace, a station on the Harlem railroad. It is owned and worked by the South Boston Iron Company. In the census year 8,960 tons of ore were produced. The mine is located in a gulch between two spurs of the garnetiferous mica-slate ridge which bounds the Dover valley on the west. No limestone occurs near the ore. The bed was originally worked in open cut, but the ore is now exploited by underground mining. The shaft is 50 feet deep; the total length of the drifts is about 800 feet. The drifts are mainly in a dense clay of various colors, but showing no lines of stratification. The ore lies in irregular bunches rather than in bands in this clay. The ore is

a "Taconic", Dana, *loc. cit.*

a teamed to near the foot of the mountain, where it is washed in an inclined sluice-box, the washed ore passing directly onto the cars. The washing is imperfect, and at some of the furnaces where the ore is used it is rewashed in a Bradford washer. The following analyses show the character of the ore:

	No. 759.	No. 760.
	Per cent.	*Per cent.*
Metallic iron	37.75	52.50
Phosphorus	0.203	0.743
Phosphorus in 100 parts iron	0.538	1.415

b

Sample No. 759 represents an average of three car-loads of washed ore. Sample No. 760 is a special sample, consisting of selected chippings of a variety of very dark-colored, crystallized (fibrous) limonite.

The *Gridley* mine (9) is near Amenia post-office, Amenia township. It is owned and worked by N. Gridley & Son. The ore is used at the Gridley furnace at Wassaic. In the census year 6,160 tons of ore were produced. The ore is all washed. A sample from a pile of 200 tons of washed ore yielded on complete analysis—

c

	No. 762.		No. 762.
	Per cent.		*Per cent.*
Sulphur	0.152	Phosphoric acid	0.950
Phosphorus	0.413	Carbon in carbonaceous matter	0.08
Iron, metallic	48.99	Hygroscopic water	0.51
Phosphorus in 100 parts iron	0.843	Water of composition	9.76
		Total	100.286
Silica	11.94		
Iron, protoxide	0.30		
Iron, peroxide	67.77	Insoluble silicious matter	15.44
Alumina	4.10		
Manganese, protoxide	0.65	Silica	11.94
Lime	1.60	Alumina (with trace of oxide of iron)	2.15
Magnesia	0.48	Lime	0.32
Iron, disulphide	0.286	Magnesia	0.20
Potassa	1.12	Potassa	0.92
Soda	0.34	Soda	0.10
Carbonic acid	0.34		
Sulphuric acid	0.06	Total	15.63

d

Carbonate of iron occurs in bunches or "horses" in the limonite. It is called by the miners "white horse" or "dead head". When freshly broken it has a gray color, but a lump will, on exposure, soon become coated with peroxide of iron. A sample was carefully selected from a pile of several hundred tons of this material which had been thrown to one side as unsalable. The chippings were, as far as possible, only of the unaltered carbonate. The sample contained—

e

	No. 763.
	Per cent.
Metallic iron	42.94
Phosphorus	0.053
Phosphorus in 100 parts iron	0.123

Adjoining the Gridley pit, on the north, is the *Amenia* mine (10), owned and operated by the Amenia Iron Company. The mine is the oldest one in the county; it was opened about the year 1760. From 1866 to 1880 it produced 172,480 tons of ore. In the census year 12,320 tons were mined. The ore is used principally in the f neighboring charcoal furnaces, but partly, also, in the anthracite furnaces on the Hudson river. The sketch (Fig. 36) shows the approximate dimensions of the pit. The ore, as is seen from the section, lies near the contact of limestone and mica slate. A sample from a few tons of the washed ore contained—

	No. 761.
	Per cent.
Metallic iron	48.28
Phosphorus	0.092
Phosphorus in 100 parts iron	0.190

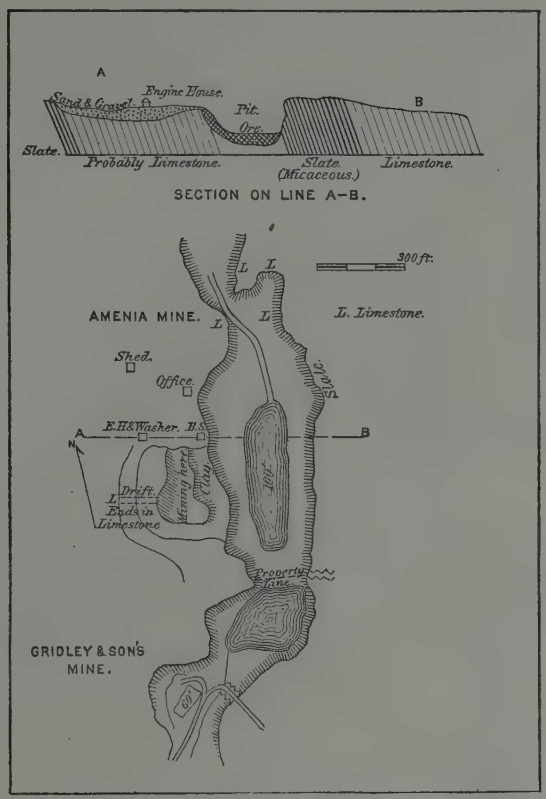


FIG. 36.—SKETCH OF THE AMENIA MINE, DUTCHESS COUNTY, NEW YORK.

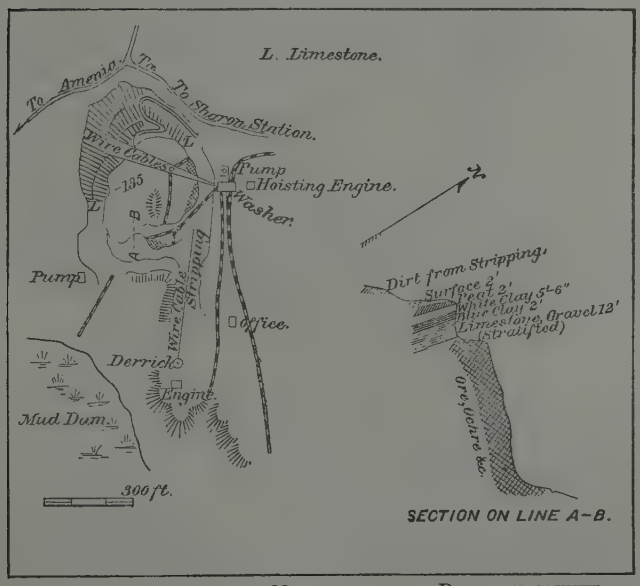


FIG. 37.—SKETCH OF THE MANHATTAN MINE, DUTCHESS COUNTY, NEW YORK.

a The *Manhattan* mine (11) is located at Sharon station, near the northern boundary line of Amenia township. It is owned and worked by the Manhattan Mining Company. A spur-track from the Harlem railroad runs to the washer, and everything is arranged for the convenient handling of the ore. In the census year the output was 21,280 tons, an amount not equaled by any other limonite mine east of the Hudson river. As shown by the sketch (Fig. 37), the pit is nearly circular in shape, and is about 135 feet deep. The ore pitches to the southwest, underneath a swamp. Limestone is exposed in several places in the pit, but no slate was seen. The ore is covered with from 10 to 40 feet of stripping. In washing there is a loss of from 30 to 75 per cent. of the material raised from the pit as ore. Many beautiful specimens of crystallized ore are found at this mine. The samples collected here contained—

b

	No. 764.	No. 765.
	Per cent.	*Per cent.*
Metallic iron	47.77	50.13
Phosphorus	0.086	0.038
Manganese, protoxide	----------	1.93
Phosphorus in 100 parts iron	0.180	0.076

Sample No. 764 is from 3 car-loads of washed ore; sample No. 765 consists of selected chippings of a crystallized ore, with jet-black, highly-polished surface.

The *Maltby* mine (12) is near Spencer's corners, Northeast township, about 6 miles north of Sharon station, and is owned by Caleb S. Maltby. It is an old mine, having c been opened in the last century. The ore is used in the Phœnix furnace (which belongs to Mr. Maltby). No ore has been raised since March, 1879, as sufficient stock had accumulated to last the furnace for more than a year. When visited, in September, 1880, preparations were being made to resume mining. The pit is 100 feet deep. The ore lies between slate on the north and limestone on the south. The following analyses show the character of the ore:

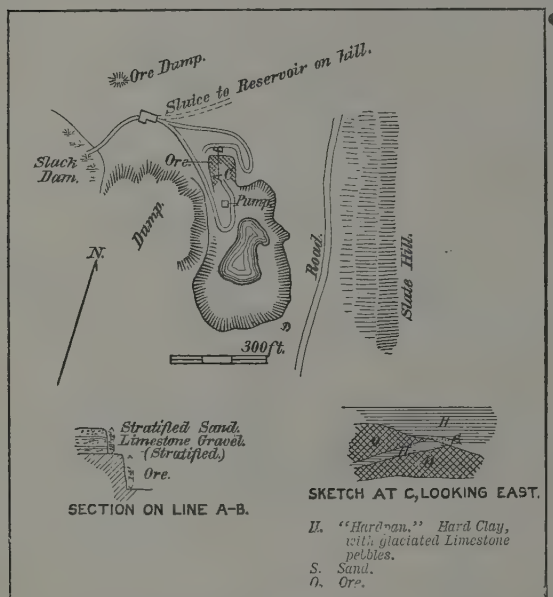


FIG. 38.—SKETCH OF THE RIGA MINE, DUTCHESS COUNTY, NEW YORK.

d

	No. 766.	No. 767.
	Per cent.	*Per cent.*
Metallic iron	41.00	48.05
Phosphorus	0.156	0.215
Phosphorus in 100 parts iron	0.380	0.447

Sample No. 766 is from 400 tons of washed ore; sample No. 767 is from 500 tons of rock-ore.

The *Riga* mine (13) lies northwest of Maltby's, near the station of Mount Riga. It is owned and worked by the Mount Riga Iron Mining Company. The mine was opened e in 1865, and has produced a total of 60,900 tons of ore. In the census year 4,130 tons were mined. Nearly all the ore is washed. The loss in washing is about 50 per cent. of the material raised (exclusive of the stripping). The stripping is about 15 feet thick. It is partly a hard, blue clay, containing rounded and striated limestone pebbles. At one point a tongue of this clay has been forced in under the ore (see sketch, Fig. 38). A sample from a pile of 600 tons of washed ore contained—

f

	No. 768.
	Per cent.
Metallic iron	41.58
Phosphorus	0.611
Phosphorus in 100 parts iron	1.470

A second determination of the phosphorus was made, but with practically the same result.

The *Dakin* mine (14) is 1½ miles north of Mount Riga. It was opened in 1872, but was idle in 1879, and although work was resumed in the spring of 1880, no ore was raised before the close of the census year. The mine is worked under lease by the Dakin Brothers. The pit is small. The ore mined during the summer of 1880 was sent principally to Hudson, and a sample was taken there from the stock-pile. The sample contained—

a

	No. 1101.
	Per cent.
Metallic iron	40.35
Phosphorus	0.357
Phosphorus in 100 parts iron	0.885

The Dakin completes the list of active mines in Dutchess county.

COLUMBIA COUNTY.

The *Reynolds* mine (15) is in Ancram township, near the Poughkeepsie and Eastern railroad, and was first opened in 1857. It was reopened in April, 1880, after having been idle for five years. The mine is owned by James Hendrick, and is worked under lease by George Williams & Co. In the census year 2,543 tons of ore were produced. The ore is mostly used in anthracite furnaces mixed with magnetite. A sample from 50 tons of washed ore at the mine contained— b

	No. 769.
	Per cent.
Metallic iron	40.61
Phosphorus	0.056
Phosphorus in 100 parts iron	0.138

c

The ore is covered with 8 to 10 feet of sand and gravel. The pit is about 40 feet deep.

The *Weed* mine (16) is located about 1 mile north of Boston Corners. It was opened in 1780, and has yielded, it is estimated, 168,000 tons of ore. The mine is owned by the Weed Ore Company, from whom it is leased by George Williams. The ore is used in the local charcoal furnaces and on the Hudson river. In the census year 11,200 tons were produced. The ore appears to lie wholly in slate, to which it conforms in dip. The deposit is far more regular than is usual with the beds of limonite in this region. A sample of the ore from the stock-pile at Hudson contained—

	No. 1102.
	Per cent.
Metallic iron	40.21
Phosphorus	0.083
Phosphorus in 100 parts iron	0.206

d

The *Copake* mine (17) is situated near Copake furnace. It is owned and operated by Frederick Miles, the owner of the furnace. The mine is an old one. In the census year it produced 4,480 tons of ore. When visited no ore was being raised, and an average sample was difficult to collect. A sample from about 20 tons of a mixture of rock and washed ore contained—

	No. 770.
	Per cent.
Metallic iron	46.79
Phosphorus	0.424
Phosphorus in 100 parts iron	0.906

e

A sample from a pile of 75 tons of "dead head" (carbonate of iron) yielded—

	No. 771.
	Per cent.
Metallic iron	30.82
Phosphorus	0.248
Phosphorus in 100 parts iron	0.805

f

The *Hillsdale*, *Mitchell*, and *Haight* mines, all in Hillsdale township, which adjoins Copake on the north, were not worked in the census year, and were not sampled.

III. Carbonate ore.

a Carbonate ore was discovered six or seven years ago near the Hudson river, in Greenport and Germantown townships, Columbia county. Several open cuts have been made on the deposit, and a number of thousands of tons of ore have been mined. No ore was raised in the census year, however, and the mines were not visited. They were briefly described by R. W. Raymond in Vol. IV *Trans. Am. Inst. Min. Eng.*, p. 339. A sample was collected from a pile of 1,000 tons of the ore at the Hudson Iron Company's furnace, and contained—

	No. 1103.
	Per cent.
Metallic iron	41.41
Phosphorus	0.159
Phosphorus in 100 parts iron	0.384

b

The ore represented by the sample was partially peroxidized. The mines are owned by the Columbia Spathic Ore Company.

With the exception of the above there are no mines of the carbonate of iron in the state.

IV. Fossil ore.

c The Clinton group of the Upper Silurian formation, containing the fossil ore, forms a narrow but unbroken belt which "sweeps along the hills south of the Mohawk valley westward past Syracuse, Rochester, and Niagara toward Detroit". Oxide of iron occurs at about the same horizon throughout the extent of this belt as far west, at least, as the Genesee river, but probably it is not always in workable thickness. It is to-day actually mined only in parts of Oneida and of Wayne counties. In Oneida county the ore was not mined in the census year east of Utica. West of Utica beds were worked in New Hartford, Kirkland, Westmoreland, and Verona townships. No ore has recently been mined between the town of Verona, in Oneida county, and the town of Sterling, in Cayuga county, but Mr. Vanuxem (*a*) observed it at several localities in Madison county. A bed was opened near the town of Sterling, near the western town (and county) line, and immediately north of the Lake Shore division of the Rome, Watertown and Ogdensburgh railroad, in 1874. But little ore was dug, however, and the mine has been idle for d several years. A few miles west of the above, in the town of Walcott, Wayne county, ore was dug many years ago for the old Walcott furnace. This bed, too, is now idle. In the town of Ontario, Wayne county, ore has been dug for many years, and, so far as is now known, this is the western limit of the bed of workable ore in the state.

ONEIDA COUNTY.

In Oneida county there are, according to Mr. Vanuxem, (*b*) two beds of ore separated by about 20 feet of greenish-blue shales, with thin layers of the same colored sandstone, containing fucoids. The lower ore-bed rests upon a thin sheet of sandstone, below which there are 35 to 40 feet of shale, then a thick bed of sandstone, quarried in many localities for building-stone, and then another series of shales resting upon the Oneida conglomerate. The members of the Clinton group vary greatly, however, in their lithological character with their geographical position. e Associated with the upper ore stratum is a mixture of limestone, shale, etc. The upper bed is thicker than the lower one, but the ore is said to be less pure.

At no point visited by the writer were the two beds worked near each other, and the horizon of the different openings was not fully determined. But from Mr. Vanuxem's descriptions it is believed that the ore sampled in New Hartford, Kirkland, and Westmoreland townships was principally, if not entirely, mined from the lower bed, while that from Verona township came from the upper bed.

In New Hartford, Kirkland, and Westmoreland townships the ore is oölitic; it is of medium hardness, and reddens everything with which it comes in contact. In Verona township the ore is harder and is not oölitic. It resembles the "hard fossil" ore of the Juniata valley, Pennsylvania. The earthy material found near the outcrop of the fossil ore in Pennsylvania, and there known as "soft fossil", occurs only in small quantities. The ore-bed dips toward the southwest at an angle equivalent to a fall of about 1 foot in a hundred. Excepting near Clinton f the ore is exploited only by stripping and quarrying.

Davis' ore-bed (1) (*c*) is situated in the town of New Hartford, about 1 mile east of Washington mills. The outcrop has been worked on three sides of the hill. A section on the north side of the hill, where ore was being dug when the locality was visited, shows 15 inches of a soft, rich-looking oölitic ore, covered with 9 feet of olive

a Geology Third District, p. 88. *b Geology Third District*, p. 84. *c* See map, Fig. 39.

shale, and 3½ feet of soil and gravel. The greater part of the shale is soft and can be removed with the pick, but a that immediately over the ore requires blasting. The ore-bed dips into the hill so that the stripping will increase as the breast advances. A sample from a few tons of the ore yielded, on analysis—

	No. 1323.
	Per cent.
Metallic iron	43.76
Phosphorus	1.116
Phosphorus in 100 parts iron	2.550

The bed is worked by J. G. Egbert. In the census year 3,360 tons of ore were produced from this and the b adjoining (Norton's) farm.

West of the above bed the ore has been entirely eroded by the creek which flows northward through the middle of New Hartford township. Crossing this valley the ore horizon is again reached near the eastern town-line of Kirkland, about 4 miles distant from the Davis bed. From the town-line the ore-bed has been worked almost continuously as far west as Clinton, where it has been eroded by the Oriskany creek.

c

d

FIG. 39.—MAP OF A PORTION OF ONEIDA COUNTY, NEW YORK, SHOWING POSITION OF FOSSIL ORE MINES.

At the *Wells* bed (2) there is almost 21 inches of ore covered with 8 to 10 feet of shale and 4 to 8 feet of gravel e and soil. The bed is worked by the Franklin Iron Company. A sample of the ore from a pile of 400 tons contained—

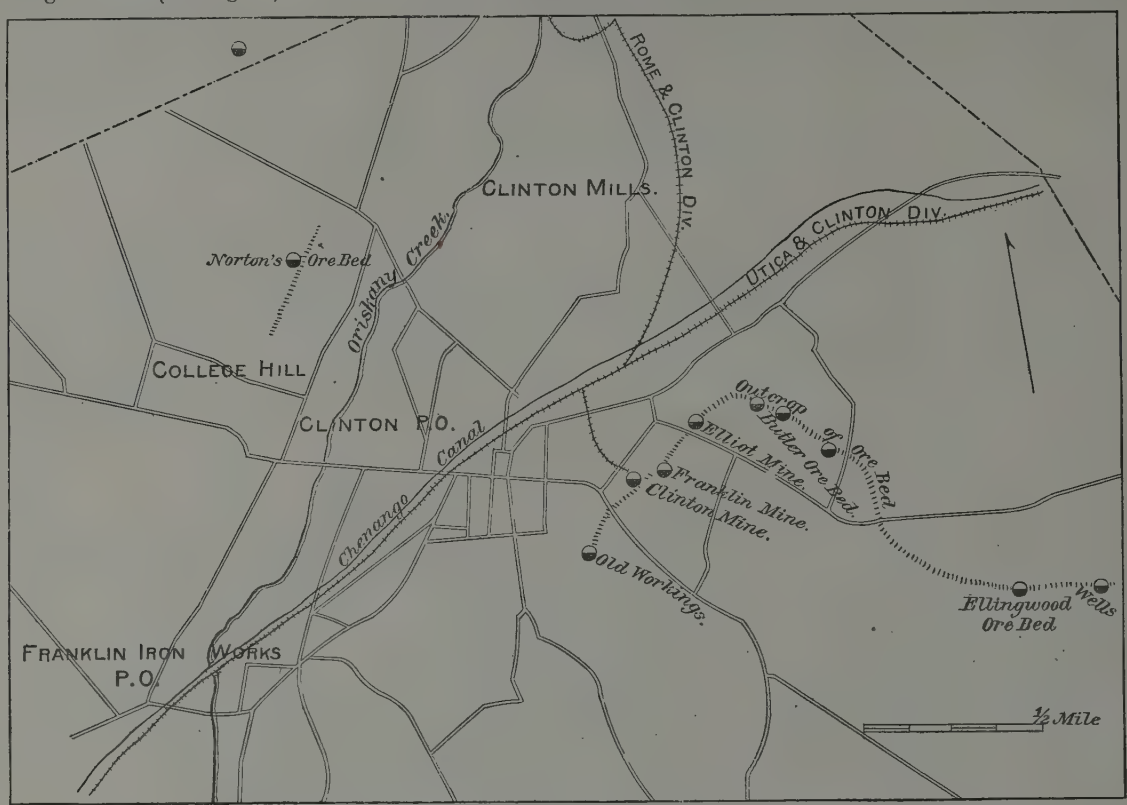
	No. 1330.
	Per cent.
Metallic iron	46.79
Phosphorus	0.640
Phosphorus in 100 parts iron	1.368

The Ellingwood farm lies west of the Wells. No ore was being dug here in June, 1881. The ore was analyzed by Mr. J. B. Britton in February, 1880, for the Franklin Iron Company, with the following results:

f

	Per cent.		*Per cent.*
Alumina	3.98	Undetermined matter and loss	0.443
Lime	6.66	Metallic iron	41.05
Magnesia	2.17	Oxygen with the iron	17.15
Silica	10.14	Total	100.000
Water and carbonic acid	15.14		
Phosphoric acid	2.557	Phosphorus	1.117
Sulphur	0.51	Phosphorus in 100 parts iron	2.721
Oxide of manganese	0.20		

a A short distance west of the Ellingwood farm the line of outcrop of the ore bed bends sharply to the northward, crossing the road (see Fig. 40).



b

c

d

FIG. 40.—MAP SHOWING THE OUTCROP OF THE FOSSIL ORE-BED NEAR CLINTON, ONEIDA COUNTY, NEW YORK.

The *Butler* ore-bed is located north of the road. It is worked by Elliott & Bronson, and the ore is shipped to Albany and elsewhere. The ore is 23 inches thick. A sample contained—

	No. 1329.
	Per cent.
Metallic iron	45.73
Phosphorus	0.554
Phosphorus in 100 parts iron	1.211

e

West of the Butler bed the outcrop takes a southwesterly direction along the eastern side of the Oriskany valley. Here all the ore that it would pay to mine by stripping has been removed, and underground mining is being resorted to.

At the *Franklin* and *Clinton* mines (owned and operated by the Franklin Iron Company) the ore has a total thickness of about 25 inches. It lies in two "tiers". The under "tier" is 8 inches, and the upper one 16 to 17 inches thick. The "tiers" are separated by 12 to 15 inches of shale. Above and below the ore there is usually a few inches of ferruginous sandstone—the top and bottom rocks of the miners. This rests upon, or is covered with, green shales. The ore will average, it is said, 2 tons to the square yard. The long-wall system of mining is employed. The rock from the roof, which it is necessary to take down that the men may have room to work, is f "gobbed" up behind the miners as the wall advances, and is sufficient in general to support the roof. A little timbering is used along the gangways only.

The ore is all shipped by rail to the Franklin Iron Works. The following analysis is of a sample from a pile of 2,300 tons of ore at the furnace, and represents the output from the two mines:

	No. 1322.
	Per cent.
Metallic iron	44.22
Phosphorus	0.710
Phosphorus in 100 parts iron	1.606

The following analyses of this ore made for the Franklin Iron Company are here inserted by permission: a

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Peroxide of iron	63.00	79.98	71.82	42.97
Protoxide of manganese	0.15	Trace.	1.63	0.37
Alumina	5.45	2.40	3.91	4.13
Lime	6.20	1.54	3.97	8.57
Magnesia	2.77	0.30	2.21	1.96
Silica	12.63	0.98	0.31	0.31
Carbonic acid	6.15	4.39	2.47	9.47
Water	2.77			
Phosphoric acid	1.50	1.239	2.096	1.534
Sulphur	0.23	None.	None.	0.837
Insoluble silicious matter	.....	.....	11.03	29.41
Undetermined matter and loss	.....	0.171	0.554	0.439
Total	100.85	100.00	100.00	100.00
Metallic iron	44.10	56.37	50.68	30.08
Phosphorus	0.65	0.541	0.915	0.670
Phosphorus in 100 parts iron	1.474	0.959	1.805	2.227

b

No. 1 is an average of a pile of ore from the Franklin and Clinton mines, and was made by Prof. A. H. Chester, March 20, 1873. The other three analyses are by J. B. Britton, and were made in the spring of 1880. No. 2 is of c a sample of ore from the Franklin mine; No. 3, a sample from the Clinton mine; and No. 4, a sample from the bottom tier in the Franklin mine.

The *Elliott* mine, northeast of the Franklin, is worked by Elliott & Bronson. In the census year Elliott & Bronson raised 11,380 tons of ore. The Franklin Iron Company's mines produced 16,420 tons of ore the same year.

On the west side of the Oriskany valley ore is being dug on Norton's farm, near Clinton mills. The bed is about 21 inches thick. The hill rises rapidly from the present workings, and underground mining will soon have to be resorted to or the bed abandoned. At the present breast the ore is covered with 6 feet of hard shale and 15½ feet of soft shale, gravel, and soil. The ore is soft and apparently rich.

A sample from a pile of 30 tons contained—

d

	No. 1328.
	Per cent.
Metallic iron	39.88
Phosphorus	0.665
Phosphorus in 100 parts iron	1.668

Northward of Clinton mills, and about a mile west of the Kirkland furnace, in Westmoreland township, ore has been dug on the Laughlin and Pryer farms by the Kirkland Iron Company. When visited in June, 1881, the work was confined to the *Pryer* bed (9). The bed is 18 inches thick, and will average a ton and a quarter of ore to the square yard. A sample taken at the stock-pile at the furnace contained—

e

	No. 1324.
	Per cent.
Metallic iron	42.90
Phosphorus	0.753
Phosphorus in 100 parts iron	1.755

At the present breast there is no hard shale above the ore, but the latter is covered with 14 feet of clay, gravel, and soil.

Three-quarters of a mile northwest of Pryer's farm, and on the north side of a ravine formed by a tributary to the Oriskany creek, is a comparatively small and isolated patch of ore which has been opened upon on Derwin's f farm (10). Previous to the present summer (1881) no ore had been dug here for several years. Work was resumed on June 1 by Mr. Norton. The ore is about 16 inches thick, but it is more or less mixed with silicious matter, and probably not more than two-thirds of it is fit for market. A sample from a pile of about 100 tons of sorted ore contained—

	No. 1325.
	Per cent.
Metallic iron	40.40
Phosphorus	0.693
Phosphorus in 100 parts iron	1.715

a Verona post-office is about 9 miles west of Kirkland. Ore is being dug at two localities near the village.

John Klein's ore-bed (11) is within the village limits. The ore is only 10 or 12 inches thick. It is covered with not more than 6 feet of stripping. The ore is very full of fossils, but it is not oölitic, and it differs from the Westmoreland and Kirkland ore in being much harder and in not staining the fingers on handling. About 250 tons of ore were shipped in the census year. A sample from a few tons contained—

b

	No. 1327.
	Per cent.
Metallic iron	21.85
Phosphorus	0.248
Phosphorus in 100 parts iron	1.135

On *Caglin's* farm (12), west of the New York Central railroad, and about 1 mile from Verona post-office, the ore lies near the surface, and lumps of it are found in the soil. The property has recently been leased to the Onondaga Iron Company. The ore lies underneath a swamp, and much trouble has been experienced from the water. But little ore has been raised. The bed is 15 to 17 inches thick. The ore resembles the Klein ore. A sample from a pile of about 100 tons contained—

c

	No. 1326.
	Per cent.
Metallic iron	40.27
Phosphorus	0.328
Phosphorus in 100 parts iron	0.815

WAYNE COUNTY.

The ore-bed worked in Ontario township is, according to Professor Hall, (*a*) the lower bed. Professor Hall gives the following section on the Genesee river: Upper limestone, 18 feet 4 inches; upper green shale, 24 feet; pentamerus limestone, 14 feet; iron-ore bed, 14 inches; lower green shale, 23 feet.

d The place for the upper bed of iron ore is below the upper limestone. It is wanting in this section, and was not identified west of Sodus point, in the north central part of Wayne county.

In Ontario township the ore-bed dips southward at the rate of about 15 inches in the hundred feet. Its outcrop extends in an east and west direction, and has been opened upon in an almost continuous

e line across the town, exposing a breast of ore 5 to 6 miles long and 15 to 20 inches thick. The ore is exploited by stripping and quarrying. At present 12 to 15 feet is considered the limit in the thickness of stripping, beyond which it does not pay to work. Before this limit is reached a width of several hundred feet of ore may often be removed. No underground mining has been attempted. The surface

f material removed from the ore preparatory to quarrying is chiefly drift and partially decomposed shale.

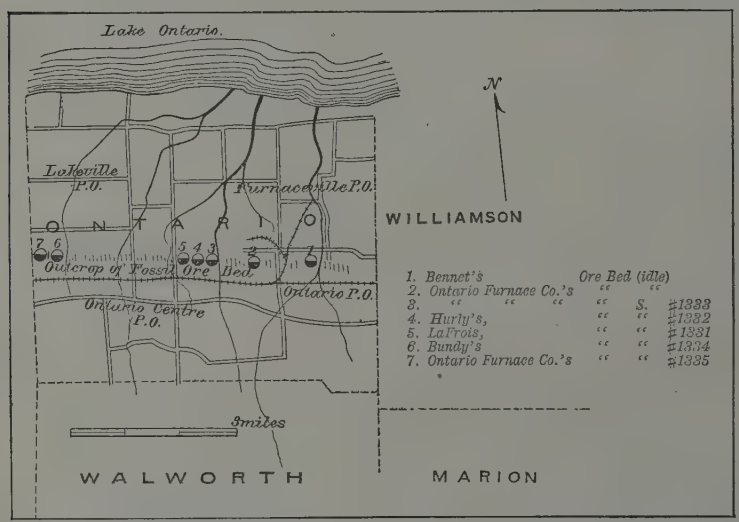


FIG. 41.—MAP SHOWING THE OUTCROP OF THE FOSSIL ORE-BED IN ONTARIO TOWNSHIP, WAYNE COUNTY, NEW YORK.

The location of the "beds" worked in June, 1881, is shown on the map, Fig. 41.

In the census year a total of 48,389 tons of ore was shipped from this town.

Bennett's bed (1), the easternmost one recently worked, is now idle; 6,720 tons of ore were dug here in the census year.

West of Bennett's farm the Ontario Furnace Company have a long line of workings. At (3) the ore is 20 inches thick. It is represented by sample No. 1333.

West of the above Hurly Brothers have recently begun digging ore. At (4) the bed is 20 inches thick. The character of the ore is shown by sample No. 1332.

---

a Geology Fourth District, pp. 61, 67.

Adjoining Hurly's on the west J. La Frois is working a bed (5). Sample No. 1331 is from a pile of 150 tons a
of the ore. The bed is 20½ inches thick.

Bundy's ore-bed (6) is about 2 miles west of La Frois'. The ore is 14 inches thick, and will run 1 to 1¼ tons to the square yard. Sample No. 1334 was taken from a pile of 30 tons of the ore.

The Ontario Furnace Company is working a bed (7) west of Bundy's, and not far from the western town-line. The ore is 18 to 20 inches thick.

The analyses of the foregoing samples resulted as follows:

	No. 1333.	No. 1332.	No. 1331.	No. 1334.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	41.46	40.73	42.25	38.36
Phosphorus	0.578	0.531	0.481	0.471
Phosphorus in 100 parts iron	1.394	1.304	1.138	1.254

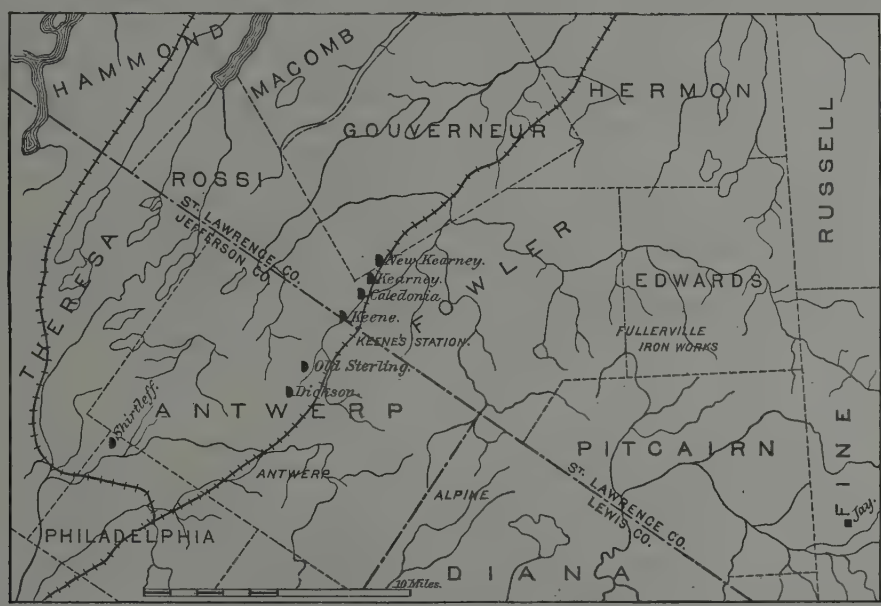
b

The ore resembles that mined near Clinton, Oneida county, with the exception that it is usually in larger grains which are more or less flattened.

V. Hematite.

The mines of hematite at present worked in the state occupy a single belt which extends from the town of Philadelphia, in Jefferson county, in a northeasterly direction to the town of Gouverneur, in Saint Lawrence county. c

The mines recently in operation are the Shirtleff, Dickson, Old Sterling, and Keene, in Jefferson county, and Caledonia and Kearney, in Saint Lawrence county (see map, Fig. 42).



d

e

Fig. 42.—Map showing the location of the Hematite ore-mines in Jefferson and Saint Lawrence counties, New York.

From these six mines there was produced in the census year 94,510 tons of ore.

With the exception of the Dickson and the Keene, the above-named mines have been worked for many years, and were described by Dr. Emmons in his *Report on the Geology of the Second District.* Several localities mentioned f
by Dr. Emmons are no longer worked. Among these are the Tate and Polley mines in Hermon township, Saint Lawrence county, northeast of Gouverneur. Ore has recently been discovered in Macomb township, near Black lake, but the property has not yet been developed.

The ore from the several mines sampled is much the same in general appearance, consisting of an amorphous red powder or mass, in which are imbedded various sized lumps or concretions of hard specular ore. The latter is close-grained, and has a steely luster; it is very hard. Specimens were obtained in which the ore has a mammillary structure, and scales of micaceous specular ore were occasionally observed. The amorphous mass has an unctuous feel and strongly soils whatever comes in contact with it. Its color differs slightly in the different mines, so that the ores can usually be distinguished.

a The ore-formation is made up of the ore above described and a silicious-magnesian rock. The silicious material is usually a very compact, brownish sandstone or quartzite; but sometimes masses of white quartz occur. The magnesian rock is greenish, unless discolored by the iron ore, and resembles the rock underlying the ore-formation, except that the latter is often schistose, while the former is usually massive. It is called serpentine by Emmons. The silicious and magnesian rocks are so associated in the ore-formation as to suggest to Emmons the idea of a breccia, and the mass is by him called a "serpentine breccia", although he says, that "usually the quartz is so perfectly incorporated with it [the serpentine] that it appears to be contemporaneous in origin".(a) The ore lies in irregular-shaped masses or pockets, in this "quartzose-serpentine". Carbonate of iron, carbonate of lime, pyrite, and other minerals have been found associated with the ore.

b The geological position and relations of the ore-formation have been variously stated. Emmons considered the ore with its associated "serpentine" to have been erupted after the deposition of the Potsdam sandstone, while Vanuxem, from facts observed in the Third district, suggested that the ore had been deposited, associated with a calcareous marl, on the primary surface previous to or during the first deposits of the sandstone.

More recently Brooks,(b) from facts observed in the Caledonia and Keene mines, concludes that there, at least, the iron-ore formation is of Lower Silurian age. He worked out a stratigraphical series of six members, the Potsdam sandstone forming the top of the series and the iron-ore formation coming immediately under the sandstone. The third member is the magnesian rock, or serpentine, which forms the foot-wall of the mines; the fourth is a crystalline limestone; the fifth, a sandstone similar in character to No. 1; the sixth, a limestone closely resembling No. 4, but differing in containing in places irregular beds or veins of granite. Underlying this series, which Brooks considers to have a minimum thickness of about 700 feet, is the Laurentian gneiss, forming a part of the great

c Archæan area of northern New York.

At the *Shirtleff* mine, in Philadelphia township, the ore is described by Emmons (c) as lying in the "primary rock". But so far as I could learn, gneiss has never been uncovered in the pit, and no outcrop of it was observed within several hundred feet of the ore. Sandstone caps the low ridge east of the pit, and it originally partially covered the ore; but whether conformably or not, I believe has not yet been determined. In the pit itself, both walls are "quartzose-serpentine". The workings consist of an open cut about 1,300 feet in length, from which all the ore has been removed, and the underground extension of the open cut to the southwest, where mining operations are now being carried on. The underground portion of the mine at the "100-foot level" is about 500 feet long. The ore-bed has been worked, therefore, for a continuous length of about 1,800 feet. The entire workings are nearly straight and have a direction of north 65° east. The dip is about 45° to the northwest. The stope, which

d is at the extreme southern end of the mine, is about 20 feet wide, but the proportion of rock is larger than usual and probably less than one-half of the material raised from the pit can be shipped. To what depth the open pit was worked cannot now be seen, as the pit has been partly filled with rock. From the northeast end of the underground mine a shaft has recently been sunk to the "200-foot level", and drifts have been started from it.

The mine is owned and operated by the Sterling Iron Company. In the census year it produced 18,990 tons of ore. A sample from 25 tons of cobbed ore ready for shipment contained—

e

	No. 1344.
	Per cent.
Metallic iron	40.40
Phosphorus	0.204
Phosphorus in 100 parts iron	0.500

The *Dickson* mine, in Antwerp township, about 2 miles north of the village of Antwerp, was opened about two years ago. The ore-mass is not quite so regular as at the Shirtleff mine; its direction and dip are, however, about the same. The pit is 70 feet deep, and is worked entirely open to day. The mine is owned and worked by the Jefferson Iron Company. It produced 8,834 tons of ore in the census year. A sample from several car-loads of ore contained—

f

	No. 1342.
	Per cent.
Metallic iron	46.32
Phosphorus	0.285
Phosphorus in 100 parts iron	0.615

The *Old Sterling* mine, also operated by the Jefferson Iron Company, is located about 1 mile northeast of the Dickson. A pit has been opened between the two mines, but it is now idle. The Sterling mine consists of an open pit

a *Geology Second District*, p. 96.

b On certain Lower Silurian rocks in Saint Lawrence county, New York, which are probably older than the Potsdam sandstone. *American Journal*, III, iv, p. 22.

c *Loc. cit.*, p. 376, under "Iron ores of Theresa".

about 400 feet long, 175 feet wide, and, at the south end, 120 feet deep. The direction of the longest axis of the pit a is north 25° east. The ore dips to the west and *pitches* to the south. There is a ridge of gneiss a few hundred feet east of the pit, but that rock has nowhere been uncovered in the mine. The present workings are at the southern end of the pit, where a wide drift has been driven southward underneath a roof of lean ore, and on the western side where a pocket or chamber of ore is being excavated. Mr. Emmons observed in the ore from this mine a golden-yellow mineral, which he says resembles *kakoxene* (a phosphate of iron). A sample of the ore from the cars contained—

	No. 1343.
	Per cent.
Metallic iron	41.92
Phosphorus	0.130
Phosphorus in 100 parts iron	0.310

b

In the census year the mine produced 21,196 tons of ore.

The *Keene* mine is situated west of Keene station, and near the boundary-line between Jefferson and Saint Lawrence counties. It is reported on the census schedules to be in Jefferson county, but Major Brooks refers to it as in Saint Lawrence county. The ore here lies quite flat and is covered with sandstone, which forms, in part, the roof of the mine. The workings are all underground, and are entered through a horizontal drift driven westward underneath the sandstone, which latter, at the mouth of the drift, forms a bluff 20 feet or more in height. Bending a little to the southward after entering, the old workings extend through the hill nearly on a level. But north of c the entrance the ore pitches downward, the formation exhibiting at the same time numerous rolls. The floor of the mine and the immediate roof of the deeper portions is the "quartzose-serpentine" rock, resembling that occurring in the mines already mentioned. Near the entrance good ore occurred close to the sandstone, which latter is there seen to be very ferruginous.

A sample of the ore from three car-loads at the mine contained—

	No. 1341.
	Per cent.
Metallic iron	42.18
Phosphorus	1.138
Phosphorus in 100 parts iron	2.698

d

The mine is operated by the Rossie Iron Works. Fifteen thousand three hundred and ninety tons of ore were raised from it in the census year.

The *Caledonia* mine, also operated by the Rossie Iron Works, is located 1 mile northeast of the Keene. The principal workings are now near the road, and are on what appears to be an anticlinal pitching southward. The ore dips to the south, southeast, and southwest. The main mine is south of the opening, and the average dip in this direction is about 30°. Sandstone covers the ore-formation at nearly all points, but it forms the actual roof of the mine in but few places. The southern end of the workings is over 150 feet below the surface. A vertical diamond-drill hole from the bottom of the mine near the pump-shaft passed through the "serpentine" floor, then through a second bed of ore, and finally into crystalline limestone. The hole terminated in the latter. I was e told that a layer of an extremely hard substance was encountered in this hole which rapidly wore away the diamonds of the drill. Specimens of the core were sent to New York to be examined, and were there pronounced to be a good quality of corundum. I did not see any of these cores myself.

Northeast of this pit is a low ridge capped with sandstone where the first ore was mined on the property. These workings, now abandoned, were figured by Emmons as the Parish mine.

East of the north end of this ridge is the Dillman shaft, from which ore is now being raised. The pit is some 125 feet deep and 100 feet long. The ore dips toward the east at about 45°. Drifts driven north and south from either end of the pit are in rock, but immediately under the skiproad the ore is 10 to 12 feet thick.

The samples of ore collected at this mine contained—

f

	No. 1338.	No. 1339.	No. 1340.
	Per cent.	*Per cent.*	*Per cent*
Metallic iron	48.36	36.78	54.16
Phosphorus	0.115	0.212	0.156
Phosphorus in 100 parts iron	0.238	0.576	0.288

Sample No. 1338 is from a pillar at the bottom of Dillman's shaft; sample No. 1339 represents ore from that part of the main mine known as Fox's pit, and sample No. 1340, ore from that part of the main mine known as Shatreau's pit. The samples were taken from the cars. Fox's pit is near the surface.

In the census year the Caledonia mine produced 21,439 tons of ore.

a At the *Kearney* mine, northeast of the Caledonia, there is an oval-shaped pit 200 feet long, 140 feet wide at the surface, and about 70 feet deep. At the bottom the pit is only 30 to 40 feet wide. The ore dips eastward under the sandstone, which has been partly removed in order to permit the mine to be worked open to day. The mine is owned by Pope, Wheelock & Co., and worked by John Webb, jr., & Co. In the census year 8,960 tons of ore were produced. The ore is represented by sample No. 1337, collected from a pile of 4,000 tons.

About one-quarter of a mile northeast of the Kearney mine Messrs. Webb & Co. have recently begun opening a pit, which they call the *Little Kearney* mine. A slope has been driven northward under the sandstone to a depth of 50 feet, at an angle of 45°. At the bottom of the slope the ore is said to be 12 feet thick. The pit was temporarily idle when visited, and was partly filled with water. A sample of the ore was collected from a few tons near the b slope, and is represented by No. 1336. The samples contained—

	No. 1337.	No. 1336.
	Per cent.	*Per cent.*
Metallic iron	46.46	44.35
Phosphorus	0.214	0.226
Phosphorus in 100 parts iron	0.461	0.509

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN NEW JERSEY.

By Bayard T. Putnam.

The most important iron ore in New Jersey is magnetite. Limonite (or brown hematite, as it is more commonly called amongst miners) has been found in a number of localities, and is mined to a small extent. Bog-ore is known to exist in the central and southern portions of the state, and in the early part of the present century it was used both in charcoal furnaces and in forges. At the present time, however, no ore of this variety is dug.

Hematite and specular ore have both been found, but in small quantities only.

Franklinite, although primarily an ore of zinc, is a source of iron also—the residues from the zinc-works being used in the manufacture of *spiegeleizen*. The ore is mined at Sterling Hill and at Franklin, in Sussex county. An ore known as franklinite iron ore has recently been found at the former-named locality. It contains so little zinc that it can be used in the blast-furnace as it comes from the mine, and yet manganese is present in sufficient quantities to make the ore valuable, mixed with more manganiferous ores, in the manufacture of "spiegel".

MAGNETIC IRON ORES.

The magnetic iron ores are confined to the belt of Archæan rocks which, as is shown on the accompanying Fig. 43, enters the state from Pennsylvania opposite Easton and crosses it in a northeasterly direction. The belt is about 10 miles wide at the Delaware river and 22 miles wide at the New York State line.

The rocks of the belt are chiefly varieties of hornblendic gneiss, or syenite, granite, and crystalline limestone, and are believed to be geologically the equivalent of the Canadian Laurentian. At nearly all localities where observations have been made the lamination planes of the rocks have a northeast and southwest trend, and dip to the southeast, usually at a high angle.

The topographical features of the region are well marked. The Archæan rocks form the highlands of New Jersey, which comprise a number of parallel ridges, having about the same direction as the belt itself. A peculiarity of these ridges is, that they are rarely cut by transverse valleys, but extend across the state in almost unbroken lines. They are separated by broad valleys, in which the Archæan rocks are sometimes covered with Paleozoic limestones and slates. It is associated with these latter rocks that the beds of limonite occur.

The magnetic ore is found in beds or layers, usually in gneiss, though occasionally in crystalline limestone. When in gneiss, the layers of ore conform to the former's stratification, and the ore-mass is to a greater or less extent mixed with the same minerals as compose the wall-rock. There is, in fact, as a rule, no sharp line of demarcation between the ore and the rock on either side, but the former gradually grades into the latter. When the percentage of magnetite to the whole mass of the rock is small, the magnetite is clearly seen to lie in layers parallel with the other mineral constituents of the gneiss; or more particularly, so far as the writer's observations go, to be closely associated with the layers of hornblende. Receding from the ore-mass, the magnetite at first disappears, and finally, too, a large part of the hornblende. The gneiss near masses of iron ore is usually of a much darker color than that found elsewhere, owing to the presence of a greater percentage of dark-green hornblende. Masses of nearly pure hornblende sometimes occur between the ore-mass and the gneiss walls; hornblende- or mica-schist next the ore is not uncommon. The walls are, however, occasionally, feldspathic-quartz rock containing but little hornblende.

Seams and masses of rock, called by the miners "horses" or "horsers", are frequently found alternating with the ore or inclosed in it. They have the same mineral constituents as the wall-rock, and the lamination of the seams or direction of the axes of the masses is parallel with the lamination of the gneiss walls.

The bodies of ore usually have a distinctly lenticular, pod-shaped, or shoot structure, the plane of the lens or pod lying in the plane of the stratification of the inclosing rock, and the axis of the pod being inclined. The inclination of the axis of a pod of ore is called its *pitch*.

a In New Jersey the *strike* of the ore-mass or "veins" (*a*) is with but few exceptions northeast and southwest; the *dip* is toward the southeast and the *pitch* toward the northeast.

The following diagrams, in part from the *Geology of New Jersey*, 1868, illustrate the pod or shoot structure. Fig. 44 shows a longitudinal section of a shoot of ore as it would appear to an observer looking toward the northwest; Fig 45, a cross-section on the line A B, supposing the observer to be looking toward the northeast; and Fig. 46, a

b

c

d

e

f

FIG. 43.

plan. The rock over the ore, *i. e.*, that under which the ore *pitches*, is called the *cap* rock; the rock under the ore is called the *bottom* rock.

In many cases a vein of ore exhibits what is called a *pinch and shoot* structure. The meaning of these terms is evident from Figs. 47, 48, and 49.

The best examples of the simple shoot structure are the Hurdtown mine in New Jersey and the Forest of Dean mine in Orange county, New York. The pinch and short structure is more common; it is finely exhibited

a The word "vein" is used in these notes in accordance with the custom of the New Jersey geologists (see *Geol. of N. J.*, 1868, p. 533), as there seems to be no simple word that so well describes the general shape of these upturned, highly metamorphosed beds.

in the large veins at Mount Hope and Hibernia. A single ore-shoot is in some instances produced by the perfect development of the pinches on either side, resulting in reducing the ore below a workable thickness, if not in cutting it out altogether. But in other cases, as at the two mines above mentioned, the ore apparently lies in the trough of a narrow cynclinal fold. (See Fig. 1, p. 5.)

The ore is a mixture of magnetite, hornblende, quartz, feldspar, mica, pyrite, and apatite in varying proportions, though all the above-named minerals are not always present in a single specimen. Hornblende is the most persistent

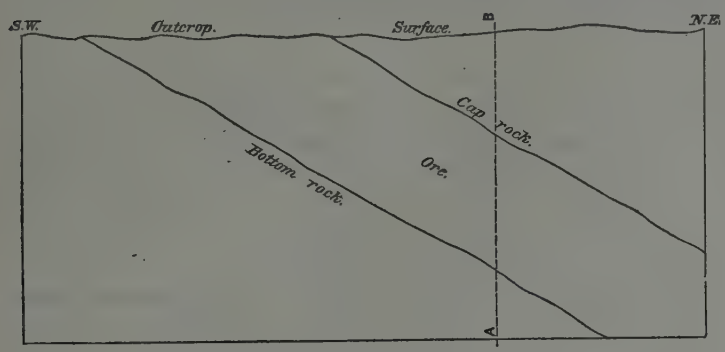


FIG. 44.—LONGITUDINAL SECTION IN PLANE OF DIP.

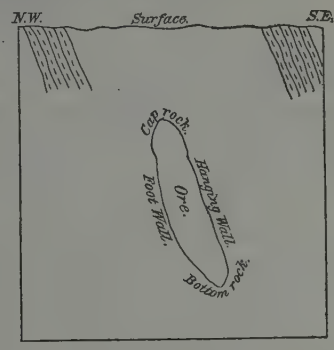
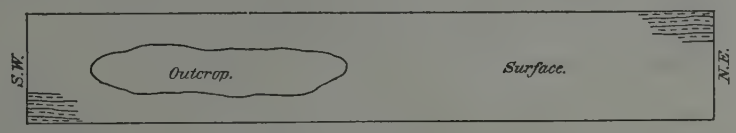


FIG. 45.—CROSS SECTION AT A—B. c

associate of the ore. Quartz is often present in small granules, as well as in massive form. Pyrite (or pyrrhotite) is very rarely entirely absent, and is so plentiful in the ores from some of the mines as to necessitate their being roasted before they can be used in the blast-furnace. Apatite in the form of light-greenish colored granules is common in many of the ores, especially in those carrying a high percentage of iron. Calcite in thin layers on fracture planes is sometimes present.



d

FIG. 46.—PLAN.

When much mica is present the ores have a laminated or schistose structure, and a similar structure is also sometimes occasioned, but in a less marked degree, by the hornblende. When free from foreign intermixture the ore often has a cubical fracture. In texture it varies from finely-granular to very coarsely-granular. The latter variety, locally known as "shot-ore", is very fragile and breaks up on handling into grains about the size of large buckshot.

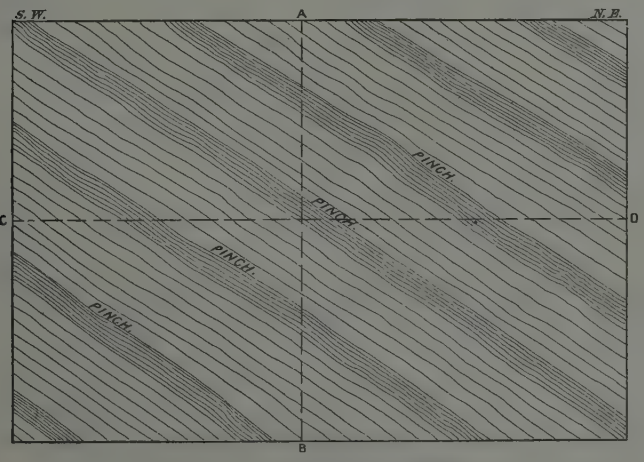
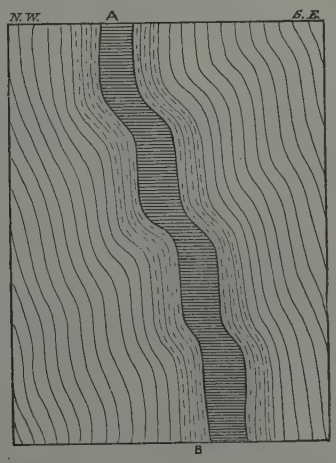


FIG. 47.—LONGITUDINAL SECTION.



e

f

FIG. 48.—CROSS SECTION ON LINE A—B.

Note.—The vein of ore is generally relatively much thinner at the pinches than is indicated on Fig. 48. The ore is sometimes completely "cut out" by the walls coming together.

a Although ores showing all varieties of texture and containing their mineral constituents in all proportions are often met with in the same mine, the prevalent character of the ore from each deposit is usually quite constant. A person familiar with the New Jersey ores can as a rule tell, on examining a pile of ore, from whence it came.

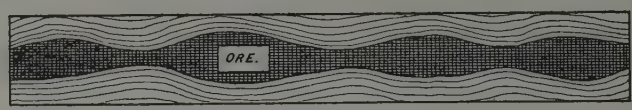


FIG. 49.—HORIZONTAL SECTION ON LINE C—D.

b For convenience in reference, Professor Cook, in the *Geology of New Jersey*, 1868, divided the range of Archæan rocks into four parallel belts. A brief description of these belts in the *Annual Report, etc., for* 1879, is as follows:

RAMAPO BELT.—This belt begins near Peapack, in Somerset county, and extends on in a northeast direction by Pompton to the state line, and, in New York, to and beyond the Hudson river. It is about 2 miles wide at the southwest, and at the New York line its width is 5 miles. Mine mountain, Trowbridge mountain, the low mountains between Danville and Boonton, the mountain extending from Boonton to Pompton, and the Ramapo mountain, are all in this belt. Its southeast border is defined by its meeting the red sandstones and conglomerates of the Triassic formation. Its northwest border is marked by a characteristic white, crystalline limestone, containing serpentine, in grains, in large masses, and in fibrous forms, known as chrysolite. There are outcrops of this limestone near Mendham, at Turkey mountain, north of Montville, near Wynokie, near Monks, and at the Old Blue mine, Ringwood.

PASSAIC BELT.—The Passaic belt is the next belt to the northwest, and the line just described is its southeast boundary. It begins at Clinton, Hunterdon county, at the southwest. Its breadth is nearly uniform and is about 5 miles. It is bounded by the red sandstone **c** and conglomerate of the Triassic age from Lebanon to Peapack. Nearer Clinton the magnesian limestone adjoins it on the southeast and south. The northwest border is marked by a continuous valley. This valley begins at the Spruce run, north of Clinton, where its first eastern branch comes in, and follows up the valley of that branch and over into German valley. Thence the Berkshire, Longwood, and West Milford valleys are the parts of this long depression. No crystalline limestone has been found in this belt, but it is distinguished by its rich mines of iron ore.

MUSCONETCONG BELT.—The valley above described, as far as it goes southwest, is the southeast boundary of this belt. From the Spruce run to the Delaware river it is bordered by the newer limestones and sandstones. The northwestern boundary is marked, as it runs from the Delaware, by Lower Harmony, up Harker's hollow, and over the mountainous divide near mount No More to Oxford furnace; thence up the valley of the Pequest to Vienna, and then up Bacon creek to Warrenville and Allamuchy; along the east foot of Allamuchy mountain and east of the Cranberry reservoir and the Roseville iron mine to the high dividing ridge between the streams running into the Musconetcong and those running into the Wallkill; from this divide it descends into the valley of the Wallkill and follows along the east border of that valley by Franklin, Hamburg, and Vernon to the New York line. Musconetcong, Pohatcong, **d** Schooley's, Hamburg, Wawayanda, and other mountain ridges are in this belt. It ends near Newburg, in New York. It is 6 to 8 miles wide, including several long valleys of magnesian limestone. No crystalline limestone has been found in it, in which respect it differs from the belt next adjoining it on the west.

PEQUEST BELT.—In the Pequest belt are included all the Azoic rocks northwest of the boundary-line just described. It extends across the state from the Delaware to the New York line. Its northwestern edge is overlaid by Paleozoic rocks. Marble, Scott's, Jenny Jump, and Pochuck mountains are in it. Its greatest breadth is about 3 miles. Crystalline limestone is very abundant in this belt, and it is also characterized by its rich zinc mines and by its iron ores containing manganese.

The following table shows the relative importance of the above-described belts as sources of magnetic iron ore:

Belt.	Number of openings.	Number of mines worked in census year. (*a*)	Total production of ore, census year.
			Net tons.
Ramapo	15	5	1,646
Passaic	115	57	540,495
Musconetcong	130	41	140,984
Pequest	42	12	56,194
Total	302	112	739,369

a Nine mines numbered in this column produced no ore in the census year; the work done was chiefly explanatory.

The Passaic belt produces over five-sevenths of the total output.

f Fig. 55 (on page 163) is a map of a group of mines near Dover, Morris county. The area covered by the map is about 11 by 25 miles. The production of the mines within this area in the census year was—

	Net tons.
Passaic belt (Morris county)	498,926
Musconetcong belt (Morris and Sussex counties)	60,298
Total	559,224

or over three-fourths of the total output of the state.

Counting the Oxford Furnace group of mines, the Mount Hope group of mines, and the Ringwood group of a mines each as one mine, (*a*) there are 25 mines which produced in the census year over 10,000 tons of magnetic ore each. The total output of these 25 mines for the census year was 585,508 net tons, or over 79 per cent. of the total output of the state.

Mines which were idle throughout the census year may generally be considered as either exhausted or as too small to pay for working. In a few cases, however, a mine has been abandoned because the ore contains too much sulphur, and in one instance at least on account of the presence of 10 or 12 per cent. of titanic acid.

In sampling the mines it was found convenient to follow the belts previously described. The Pequest belt was visited first, and the mines within its limits will first be mentioned, beginning with those situated in the southwestern part of the belt.

Many small mines were reopened in the early part of 1880, and were only worked for a few weeks. With but b few exceptions samples were taken only from those mines which were being worked when visited.

The numbers attached to the mines refer to the map (Fig. 50). Fig. 55 shows the location of the mines near Dover, on a map of a larger scale.

PEQUEST BELT.

In the southwestern portion of this belt, in Oxford and Hope townships, Warren county, a great deal of exploring has been done at different times, and twelve "mines" have been opened. From but four of these, however, viz, the Schuyler (1), the Roseberry (2), the Pequest (3), and the Hoagland (4), was ore raised during the census year. The total product from the four mines was 950 tons. The ore was not sampled.

The *Kishpaugh* mine (5), in Hope township, 2 miles northwest of Danville, on the Jenny Jump mountain, is c the only mine on this portion of the belt that has been successfully wrought. It was opened in 1871, and has yielded fully 81,200 tons of ore, including 12,710 tons raised in the census year. The mine is entered by two slopes, the one 246 feet long and the other 216 feet long, both driven on the foot-wall of the vein. The strike of the vein is northeast and southwest, and the dip is toward the southeast at an average angle of about 35°. At the bottom of the workings the ore is reported to be between 8 and 10 feet thick, but owing to the decomposed state of the hanging-wall part of the ore is left on the roof. On exposure to the atmosphere the ore soon softens and crumbles to an earthy powder. It is but slightly magnetic. A remarkable feature of the mine is the extent to which the wall-rock has disintegrated. Lagging is necessary along the slopes for a considerable distance from the surface, and even at the bottom of the mine very careful timbering is required. The rock from the mine soon falls to powder on exposure to the air. d

The following analyses show the character of the ore:

	No. 96.	No. 97.
	Per cent.	*Per cent.*
Metallic iron	49.68	54.71
Phosphorus	0.036	0.036
Sulphur	0.755	0.542
Manganese	Present.	Present.
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.072	0.066

e

Sample No. 96 is from a pile of 200 tons of ore from the northeast slope. Sample No. 97 is from a pile of 100 tons of ore from the southwest slope. The ore in both piles was mostly fine material, apparently a mixture of magnetite, hornblende, mica and chlorite (?). Only a few lumps of solid ore could be found in each pile. A lump from the pile represented by sample No. 96 consists of magnetite and green hornblende in roughly parallel and alternating layers. Small crystals of pyrite occur distributed through the specimen. Part of the hornblende has weathered to a brownish color. A specimen from the other pile contained greenish-brown mica.

The mine is worked by the Crane Iron Company, and the ore is sent to the furnaces at Catasauqua, Pennsylvania, via team to Pequest (9 miles), thence by rail.

Northeast of the Kishpaugh mine, along the top of the Jenny Jump mountain, in Hope and Independence townships, numerous exploration shafts or test-pits have been sunk on lines of magnetic attraction in search of f ore; but, so far as the writer could learn, no deposits had been found sufficiently large to pay for working, although from some of the shafts several hundred tons of ore have been raised. According to analyses published in the annual reports of the state geologist, samples (specimens ?) of ore from this district contained 49 to 63 per cent. of iron; 0.006 to 0.370 per cent. of phosphorus, and 0.65 to 2.74 per cent. of oxide of manganese.

East of the Great Meadows, which lie at the foot of Jenny Jump mountain, and near Warrenville, in Allamuchy township, several lines of magnetic attraction have been traced out and shafts opened thereon. At one of these

a In the table on page 148 these groups figure each as three mines, but on the census schedules the output from the several pits is united.

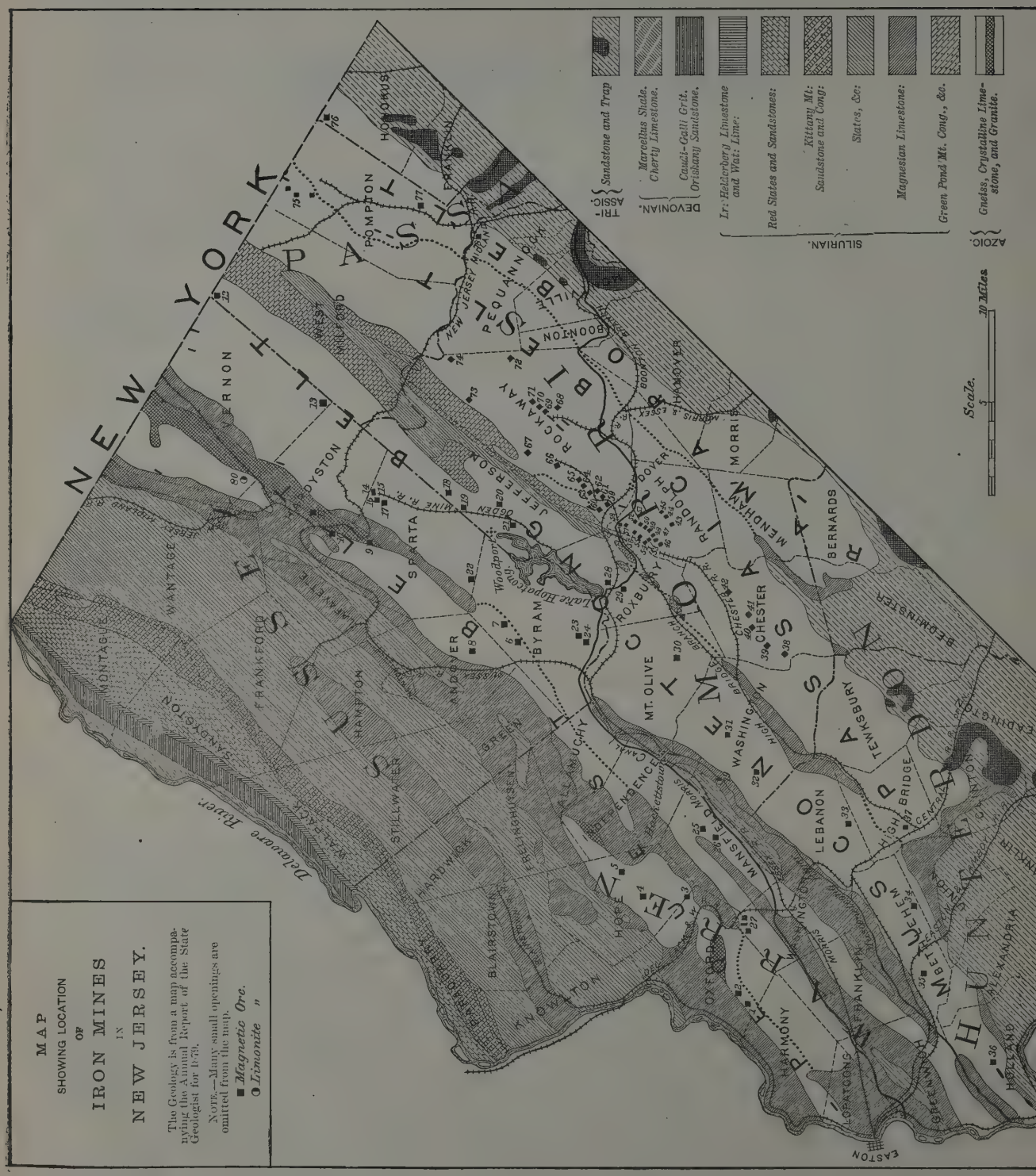

MAP
SHOWING LOCATION
OF
IRON MINES
IN
NEW JERSEY.
The Geology is from a map accompanying the Annual Report of the State Geologist for 1879.
NOTE.—Many small openings are omitted from the map.
Magnetic Ore.
Limonite "
NEW YORK
PATERSON
PASSAIC
BERGEN
SUSSEX
WARREN
MORRIS
ESSEX
HUDSON
UNION
SOMERSET
HUNTERDON
MERCER
MONMOUTH
OCEAN
BURLINGTON
CAMDEN
ATLANTIC
CUMBERLAND
GLOUCESTER
SALEM
CAPE MAY
Delaware River
Scale.
20 Miles
Sandstone and Trap
Marcellus Shale. Cherty Limestone.
Cauck-Galli Grit. Orisbany Sandstone.
Lr: Helderberg Limestone and Water Lime:
Red Slates and Sandstones:
Kittany Mt: Sandstone and Cong:
Slates, &c:
Magnesian Limestone:
Green Pond Mt. Cong., &c.
Gneiss, Crystalline Limestone, and Granite.
TRIASSIC.
DEVONIAN.
SILURIAN.
AZOIC.

FIG. 50.

"mines" some work was done in the census year toward driving a tunnel into Allamuchy mountain, from the a west shore of Allamuchy pond, in order to cut a vein of ore which outcrops on the mountain top. No ore was mined however.

Northeast of the "Livesey's Tunnel" mine, above mentioned, and about 2 miles west of Cranberry reservoir, is the old Glendon mine. The ore occurs in crystalline limestone and contains a large amount of garnet. The mine has been idle for many years. Beyond the Glendon some work was done during the census year at the *McKean* (6) mine, in Byram township, Sussex county; but only 224 tons of ore were raised. The mine was opened first in 1873, and has produced in all about 1,000 tons of ore. It is owned by John McKean, and was worked under lease by Clarkson, Bird & Son.

The *Roseville* mine (7), in Byram township, about 3 miles southeast from Andover, was reopened by its owners, the Andover Iron Company, in February, 1880, after having been idle for eight or ten years. The mine was described b in the *Geology of New Jersey*, 1868, and has changed but little since. The workings form an open cut 700 to 800 feet long, 30 feet wide, and 25 to 50 feet deep, with very irregular walls. The pit had been only partly freed from water when visited. Ore was being mined from the southwest end of the pit only, and chiefly, too, from the west wall. This wall is a crystalline limestone. The east wall is gneiss. The character of the ore changes greatly in the different parts of the pit. A sample taken to represent an average of a pile of 50 tons of sorted ore (ready for shipment) contained—

	No. 320.
	Per cent.
Metallic iron	53.92
Sulphur	0.013
Phosphorus	0.035
Phosphorus in 100 parts iron	0.065

c

The ore is teamed to the Sussex railroad and thence shipped by rail to the company's furnaces at Phillipsburg. The mine produced, in the census year, 1,347 tons of ore. The total production is estimated at 67,000 tons.

The old *Andover* mine (8), 1 mile northwest of the village of Andover, in the township of the same name, has been idle for many years. But in the spring of 1880 Messrs. Williams & Co. leased the property and opened the *Sulphur Hill* mine, immediately northeast of the old Andover workings. The accompanying sketch (Fig. 51) represents a plan of both mines, and shows also the location of the samples of ore taken. The mine is described with d a great deal of detail in the *Geology of New Jersey*, 1868. One of the peculiarities of the locality is the occurrence of specular hematite, and a great number of different minerals associated with the magnetic ore. Mr. Wurtz found: Garnet, willemite, manganese, calcite, blende, fluorspar, galena, cerusite?, chalcopyrite, malachite, azurite, magnetite, talc, mica, hematite, calamine?, limonite, pyrite, hornblende, apatite, epidote, pyrrhotite, and feldspar. The workings on Sulphur hill consist of an open pit 100 feet long by 50 feet wide and 85 feet deep, entered by a tunnel on a level with the bottom of the pit. Through this tunnel the ore and rock are taken out on tram-cars, and the water drains naturally, so that at present no machinery is required. The samples of ore collected yielded, on partial analysis—

	No. 301.	No. 302.	No. 303.	No. 304.	No. 305.	No. 306.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	42.63	36.91	32.73	62.31	63.62	41.66
Phosphorus	0.024	0.022	0.100	0.001	0.018	0.110
Sulphur	2.290	2.527	0.270	0.059	0.057	0.071
Manganese	Present.	Present.	Present.	Present.	Present.	Present.
Titanic acid	Present.	Present.	Present.	Present.	Present.	Present.
Phosphorus in 100 parts iron	0.056	0.060	0.306	0.002	0.028	0.265

e

Sample No. 301 consisted of a series of chippings taken around the north and west sides of the Sulphur Hill pit. The ore contains garnet, pyrite, and pyrrhotite in considerable quantities, while numerous other minerals are often found associated with it. The magnetite is in coarsely granular bunches and in fine intermixture with the garnet, which latter forms an essential part of the mass and gives to it a reddish color. Some pieces of the ore contain green hornblende in place of a portion of the garnet, but the garnetiferous ore forms the chief output of f the mine. Sample No. 302, from 80 tons of "cobbed" ore on the dock, was taken to represent the average run of the shipping product of the mine. The ore was all mined in the main pit. Sample No. 303 was taken from several "stringers" of soft brown ore, which occur near the outcrop of the magnetite, and often penetrate the latter to a depth of 8 or 10 feet. The ore has evidently resulted from the oxidation of the magnetite along cracks and fissures which have admitted the surface drainage. Commercially it is of little importance as the total amount is small, but its comparatively high percentage of phosphorus is noticeable. Sample No. 304 is from a small opening on the hill east of the north end of the old Andover pit. The ore is very strongly magnetic, and pieces of it exhibit polarity to a marked degree. The vein is about 3 feet wide. Sample No. 305 is from an old pillar near the north end of

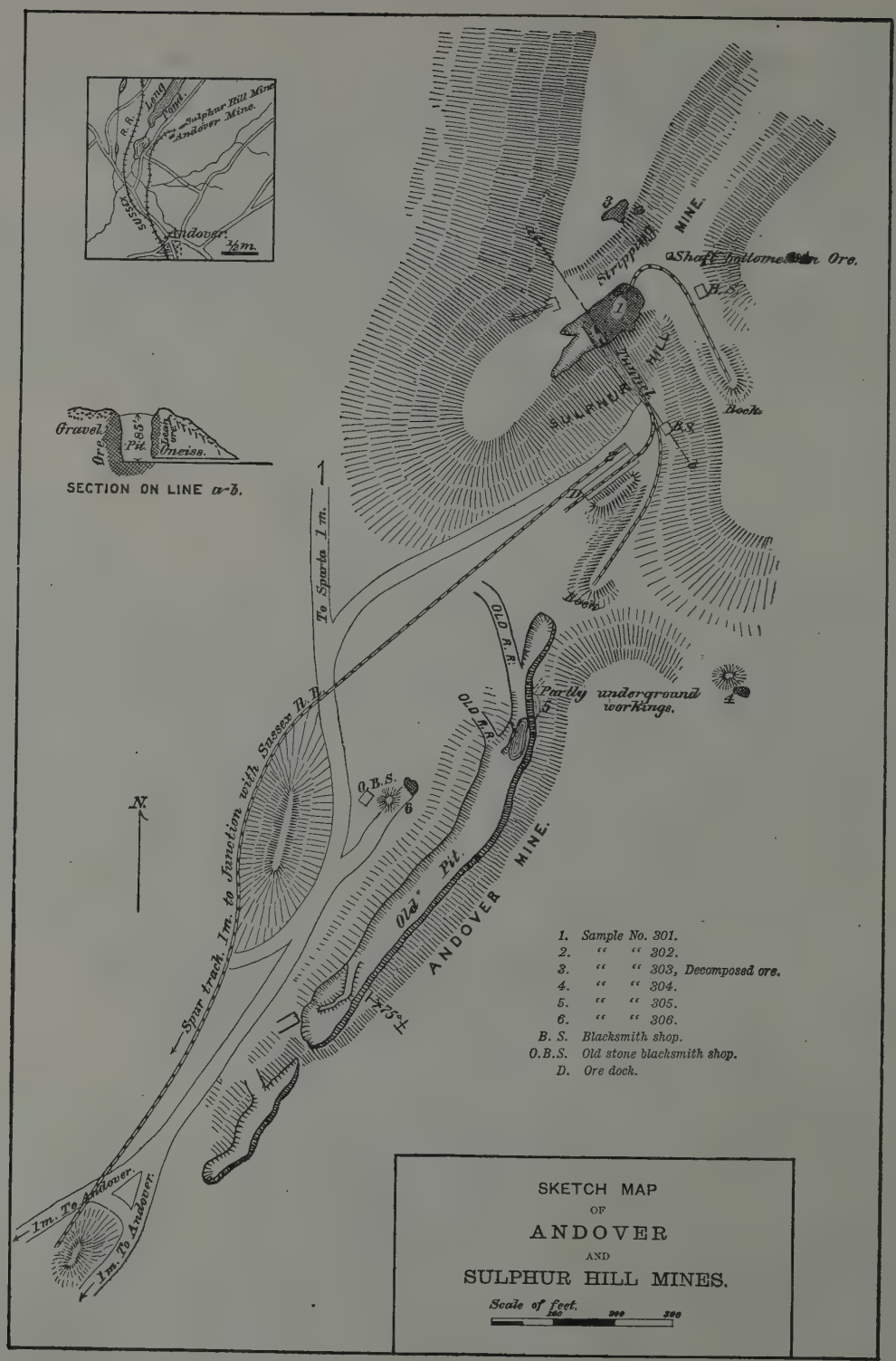

Sulphur Hill Mine
Andover Mine.
R.R.
Lead
Road
Sussex
Andover.
½m.
Gravel.
Ore.
Pit.
Gneiss.
SECTION ON LINE a-b.
SULPHUR HILL MINE.
Stripping
Shaft bottomed in Ore.
B.S.
Tunnel
Dock
To Sparta 1 m.
OLD R.R.
Partly underground workings.
O.B.S.
N.
Spur track 1m. to Junction with Sussex R.R.
Old Pit.
ANDOVER MINE.
1m. To Andover.
1. Sample No. 301.
2. " " 302.
3. " " 303, Decomposed ore.
4. " " 304.
5. " " 305.
6. " " 306.
B. S. Blacksmith shop.
O.B.S. Old stone blacksmith shop.
D. Ore dock.
SKETCH MAP
OF
ANDOVER
AND
SULPHUR HILL MINES.
Scale of feet.
100
200
300

FIG. 51.

the Andover pit. The ore gives a purplish streak, and its powder is readily taken up by the magnet; but it affects the compass-needle but slightly. If this sample represents the ore from the old pit it explains why the Andover iron was so highly prized. Sample No. 306 is from a small opening west of the old pit. A couple of men were at work here, and a few tons of ore were on the bank, but no ore had been shipped. The ore gives a reddish-brown or purplish streak, and soon disintegrates and falls to powder on exposure. The powder is largely taken up by the magnet. Sample No. 302 was subjected to complete analysis, with results as follows:

	No. 302.		No. 302.
	Per cent.		*Per cent.*
Silica	21.86	Phosphoric acid	0.051
Iron, protoxide	15.42	Titanic acid	0.13
Iron, peroxide	32.56	Hygroscopic water	0.12
Alumina	3.97	Water of composition	0.33
Manganese, protoxide	0.32	Total	100.031
Lime	18.57		
Magnesia	0.16	Per cent. of insoluble silicious matter	23.67
Iron, disulphide	4.530		
Zinc, sulphide	0.24	Silica	21.86
Nickel, sulphide	0.01	Alumina	1.08
Cobalt, sulphide	0.01	Lime	0.51
Copper, sulphide	0.12	Magnesia	0.16
Lead	Trace.	Potassa	0.05
Potassa	0.05	Total	23.66
Carbonic acid	1.58		

The ore is chiefly used in the company's furnace at Chester, New Jersey. Before being charged into the furnace it is roasted in Taylor's patent gas-kilns. A sample was collected from 100 tons of the roasted ore, and contained—

	No. 347.
	Per cent.
Metallic iron	46.53
Phosphorus	0.020
Sulphur	0.786
Phosphorus in 100 parts iron	0.043

Before the close of the census year 15,201 tons of ore were shipped from the Sulphur Hill mine. The total product of the Andover and Sulphur Hill mines together is estimated to have been in the neighborhood of 400,000 tons.

Near Franklin furnace, in Hardyston township, Sussex county, are two mines known as the *Hill* mine (10) and the *Pike's Peak* or *Furnace Vein* mine (11), respectively. The first-named is south of the furnace and is in gneiss, while the latter is in crystalline limestone. Openings have been made along the Hill Mine vein for a distance of about a half-mile, and on both sides of the Wallkill river. The present workings are southwest of the previous ones, and were begun in the summer of 1879. When visited the shaft was about 60 feet deep, and from the bottom the ore was being stoped out in either direction. A sample from a pile of 1,000 tons of ore at the top of the shaft yielded on analysis—

	No. 307.
	Per cent.
Metallic iron	27.88
Phosphorus	0.045
Sulphur	0.267
Phosphorus in 100 parts iron	0.161

The ore is an intimate mixture of magnetite and dark-green hornblende, and is somewhat deceptive on this account. It appeared to be richer in iron than is shown by the analysis. The *Pike's Peak* or *Furnace Vein* mine (11) is on the hill north of the Wallkill, and is but a few rods distant from the celebrated veins of zinc ore (franklinite, willemite, etc.) for which this region is famous. The ore-mass is in the form of a shoot, dipping to the southeast at about 55°, and pitching to the northeast. The slope on the foot-wall is 250 feet long, but at the bottom the ore has pinched out. All the ore now being mined comes from a level about 100 feet from surface and northeast of the slope. Here the ore is concentrated in two bands, the centers of which are about 5 feet apart. On either side of the center of each band the mass gradually grades off from a magnetite with calcite to a crystalline

a limestone with magnetite, the grains of magnetite always being arranged in lines parallel with the walls of the mine. The width of the stope is from 6 to 8 feet, and perhaps, on an average, 4 feet of this goes to the furnace. A sample taken from 150 tons of the ore at the furnace contained:

b

	No. 308.
	Per cent.
Sulphur	0.439
Phosphorus	0.033
Iron, metallic	33.15
Phosphorus in 100 parts iron	0.099
Silica	1.67
Iron, protoxide	14.43
Iron, peroxide	30.69
Alumina	0.28
Manganese, protoxide	2.90
Lime	17.63
Magnesia	7.53
Iron, disulphide	0.780
Iron, arsenide ($Fe\ As_2$)	0.47
Antimony, sulphide ($Sb_2\ S_3$)	0.05
Copper, sulphide	0.03

	No. 308.
	Per cent.
Carbonic acid	22.25
Phosphoric acid	0.077
Graphite	0.98
Hydroscopic water	0.06
Water of composition	0.18
Total	100.007
Insoluble silicious matter	2.41
Silica	1.67
Alumina	0.45
Lime	0.19
Magnesia	0.08
Total	2.39

c

The Hill and the Pike's Peak mines belong to the Franklin Iron Company. The ore is used at the Franklin furnace. During the census year the Hill mine produced 6,720 tons, and the Pike's Peak mine 8,960 tons of ore.

MUSCONETCONG BELT.

In the northeastern part of the Musconetcong belt, the *Centennial* mine (12), in West Milford township, Passaic county, was worked for a few months in the census year by E. H. Wright. One thousand three hundred and forty tons of ore were raised. The total yield of the mine is estimated at about 2,200 tons.

d The *Welling*, *Green*, *Wawayanda*, *Williams'*, and *Canistear* mines, all in Vernon township, Sussex county, were reopened in the census year. A couple of hundred tons of ore were raised from the *Welling* mine by M. F. Ten Eyck, but no shipments were made. The ore is reported to run low in phosphorus.

The *Canistear* mine (13) in the southeastern corner of Vernon township, near the road between Canistear and Stockholm, was reopened in 1879, and 10,000 tons of ore were mined. When visited, in March, 1880, the mine was idle, and the shafts were filled with water. The Franklin Iron Company owns the mine.

e A sample collected at the Franklin furnace from a pile of 350 tons of the ore yielded on partial analysis—

	No. 310.
	Per cent.
Metallic iron	35.38
Phosphorus	0.084
Sulphur	0.942
Phosphorus in 100 parts iron	0.237

The ore is very silicious.

f The Green, Wawayanda, and Williams' mines were in operation for a few weeks only.

Continuing in a southwesterly direction, the next mines met with are the Ogden mines, on Wallkill mountain, in Sparta township, Sussex county, 2 miles southeast of Ogdensburgh (see Fig. 52). Ore was mined at this locality in the last century. The vein has been traced and opened upon for nearly 2 miles, but only at four or five points has it been worked to any great depth. To-day the Ogden mines consist of four pits, known as the *Davenport* mine (17), the *Old Ogden* mine (16), the *Roberts* mine (15), and the *Pardee* mine (14).

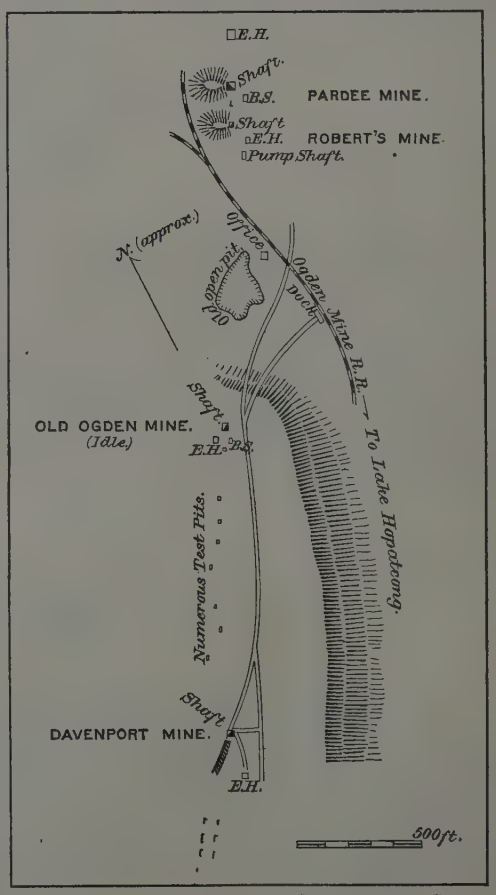


FIG. 52.—SKETCH MAP OF THE OGDEN MINES, SUSSEX COUNTY, NEW JERSEY.

The ore is all shipped via the Ogden Mine railroad to Lake Hopatcong, and thence by lake and the Morris a canal to furnaces in New Jersey and Pennsylvania. Shipments are made only in the summer season.

The *Davenport* mine is on a shoot of lean ore, which pitches toward the northeast at an angle of about 35°. The walls are almost vertical, and are quite smooth and solid; so that, although the pit in the northeastern end is 165 feet deep, and is open to daylight, no pillars have been left, and very little timbering is required. At the stope the vein is 6 to 8 feet wide. The ore is raised in buckets, but the men enter and leave the mine on the incline formed by the "bottom rock" of the shoot of ore. The chief gangue of the ore is colorless quartz, which often forms 50 per cent. (by volume) of a lump. Pyrite is present in small quantities. A sample was taken from a pile of 200 tons of ore on the railroad dock, and contained—

	No. 314.
	Per cent.
Metallic iron	47.76
Phosphorus	0.398
Sulphur	0.208
Phosphorus in 100 parts iron	0.833

b

The mine is worked by Atkins Brothers, under lease from the owners, the Sussex Iron Company. The ore is shipped to the lessees' furnaces at Pottsville, Pennsylvania. During the census year 1,120 tons of ore were mined. The mine was not, however, reopened before the winter of 1880. It had been idle since 1873.

When visited, the *Old Ogden* mine was idle, but it was afterward reopened by its owners, the Coplay Iron c Company, and 2,464 tons of ore were shipped from it before May 31.

The *Roberts* mine is owned by the Ogden Iron Company, and is now worked by the Allentown Rolling-Mill Company. The mine was reopened in June, 1879. The production of ore in the census year was about 16,800 tons. There are two shafts to the mine, about 130 feet apart. The northeast shaft, through which all the ore is raised, is 270 feet deep; it starts from the surface nearly vertically, but following the foot-wall of the vein, flattens at a depth of 75 feet, the vein being there bent toward the hanging-wall, pinching down to 18 inches in width. Below this pinch the walls dip at an angle of about 65° to the southeast, and at the present level the vein is about 15 feet wide. Stoping is progressing both east and west from the shaft. Samples taken across each stope yielded on partial analysis—

d

	No. 312.	No. 313.
	Per cent.	*Per cent.*
Metallic iron	63.91	64.22
Phosphorus	0.613	0.746
Sulphur	0.133	0.105
Phosphorus in 100 parts iron	0.959	1.162

Sample No. 312 is from the east stope, about 30 feet from the shaft. Sample No. 313 is from the west stope, about 50 feet from the shaft. Both stopes are on the same level, about 270 feet below surface.

The *Pardee* mine adjoins the Roberts on the northeast, the two mines being on the same shoot of ore. Between the shafts of the two mines the shoot pitches under a "cap-rock". The Roberts shaft starts from the surface in e ore, while the Pardee shaft was sunk through the cap-rock before the ore was reached. The Pardee shaft is 300 feet deep, and at the stope, 60 feet northeast of the bottom of the shaft, the ore is reported to average 20 feet in width. The shaft is within 10 feet of the property line, so there is of necessity but one stope in the mine. A sample was taken from a pile of about 2,500 tons of ore stocked at the mine. It yielded on complete analysis—

	No. 311.		No. 311.
	Per cent.		*Per cent.*
Sulphur	0.113	Phosphoric acid	2.444
Phosphorus	1.067	Titanic acid	0.09
Iron, metallic	59.23	Water of composition	0.38
Phosphorus in 100 parts iron	1.801	Total	100.306
Silica	7.63	Per cent. insoluble silicious matter	9.69
Iron, protoxide	25.34		
Iron, peroxide	56.37	Silicia	7.63
Alumina	3.08	Alumina (with a trace of iron oxide)	1.99
Manganese, protoxide	0.34	Lime	0.04
Lime	4.09	Magnesia	0.02
Magnesia	0.27	Total	9.68
Iron, disulphide	0.212		
Carbonic acid	0.06		

f

a The Pardee mine is owned by the Ogden Iron Company. It is now worked by the Musconetcong Iron Company, and the ore is used at Stanhope. During the census year 8,089 tons of ore were mined.

About 4 miles due south of the Ogden mines and 3 miles northeast of Woodport, at the head of Lake Hopatcong, is the *Ford* mine (18), in Jefferson township, Morris county. It is owned and operated by the Musconetcong Iron Company. A spur-track from the Ogden Mine railroad passes the mine, and the ore is shipped to Stanhope via this railroad, Lake Hopatcong and the Morris canal, there to be used in the company's furnaces. The mine has two shafts. No. 2 (the northeast shaft) is 200 feet deep. The stope is 250 feet northeast of the shaft, where the vein is 15 feet wide. Fifty feet above this level a drift has been driven 150 feet beyond the stope. At the level of this drift, *i. e.*, about 150 feet below the surface, the vein has been opened for a length of about 750 feet. Shaft No. 1, now used as an auxiliary pump shaft only, is 150 feet southwest of No. 2, and is bottomed in b the bottom rock of the shoot of ore. The bottom rock pitches toward the northeast at an angle of about 30°. The ore has been followed from the surface along the bottom rock and has practically been all exploited southwest of the hoisting-shaft.

A sample of the ore was collected from the stock-pile at the mine. This stock-pile contained some 6,000 tons of ore, part of which had been mined several years since. The mine was idle for two or three years previous to the spring of 1879. The sample yielded on partial analysis—

c

	No. 315.
	Per cent.
Metallic iron	50.70
Phosphorus	0.313
Sulphur	0.753
Phosphorus in 100 parts iron	0.617

The ore is finely granular, and contains hornblende, pyrite, and apatite. During the census year 17,584 tons of ore were shipped from the mine.

Less than two rods east of the shoot of ore now being worked, is another and parallel shoot, known as the old Glendon vein. It was from this that the first ore was raised, the western shoot having been discovered by a drift from the old mine. No work has been done on this vein for many years; but when the locality was visited, an old shaft, 200 feet northeast of No. 2 shaft, was being repaired preparatory to resumin g mining. At the bottom of d this shaft the vein is 3 feet wide. The ore is pyritiferous.

The *Scofield* mine, owned by the Crane Iron Company, is believed to be on the Glendon vein. It lies adjacent to the Ford on the northeast. It has been idle since 1874.

The *Dodge* mine (19), 1 mile southwest of the Ford, was, like the latter, idle for some years previous to 1880. The pumps were started in January, and when visited the mine was dry and the shaft was being repaired, preparatory to resuming mining operations. The mine is owned by William E. Dodge, jr., and is worked by the Weldon Iron Company. Before May 31, 358 tons of ore were raised. The structure of the ore-mass is similar to that at the Ford mine. The pitch of the shoot is the same (30°), and the only exceptional feature is that the vein dips to the northwest. The hoisting-shaft is 165 feet deep and is bottomed in the bottom rock of the shoot, along which the ore has been worked from the surface. Descending along the bottom rock, at a point about 230 feet from the foot of e the shaft, the cap-rock makes a sharp bend downward and apparently cuts the ore entirely off.

Exploration into the foot (east) wall at this point resulted in the discovery of another shoot of ore, separated from the first one by 10 to 12 feet of rock. Judging from the size of the chamber this second shoot must have been 15 or 20 feet wide at the point where it was broken into. But toward the southwest the walls come together and the vein narrows to about 8 feet. A drift has been started from this chamber southwestward, and the only ore in sight in the mine, excepting on the floor at the bottom of the incline, when visited, was in this drift. The occurrence of two parallel shoots of ore near together is a peculiarity of this district. The most perfect example of this "twin" structure is seen at the Weldon mine.

About 3,000 tons of lean ore mined several years ago were stocked on the railroad dock at the mine. In the process of loading this ore the rock is sorted out. A sample was taken from 4 car-loads of ore ready for shipment, f and contained—

	No. 316.
	Per cent.
Metallic iron	50.70
Phosphorus	0.168
Sulphur	0.443
Phosphorus in 100 parts iron	0.331

About one-eighth of a mile west of the mine, and near the Ogden mine railroad, a shaft is being sunk on a line of magnetic attraction. The shaft is 60 feet deep, and at the bottom the vein is 3 feet wide. In appearance the ore is similar to that from the mine.

The *Weldon* mine (20), 1 mile east of Woodport, was also reopened in the winter of 1880, after having been idle a for six or seven years. In the census year 1,276 tons of ore were raised. The mine is the property of William E. Dodge, jr., and others, and is worked by the Weldon Iron Company. The ore lies in two shoots, which pitch toward the northeast at the same angle (30° to 32°), and slightly approach each other as they descend. At the shaft, 80 feet below the surface, the shoots are 29 feet apart; while at the stopes, about 200 feet northeast of the shaft, measured on the bottom-rock, they are separated by but 7½ feet of rock. Both shoots dip to the southeast, at an angle of 75° to 80°. The height of the shoots, *i. e.*, the normal distance between the bottom and cap rocks, is about 30 feet. The stope in the west shoot is 3 to 4 feet wide; in the east shoot, 4 to 5 feet wide. The track is laid down the east chute, and the mine cars are switched at the bottom of the mine into either stope, the rock between the shoots being cut through to allow of their passage.

The ore is a finely- to coarsely-granular magnetite, with quartz and hornblende. A portion of the ore is b "shotty", and resembles the Hurdtown ore. A sample was taken from a pile of about 300 tons of the ore at the mine and yielded on analysis—

	No. 317.
	Per cent.
Metallic iron	54.80
Phosphorus	0.554
Sulphur	0.266
Phosphorus in 100 parts iron	1.010

The *Hurdtown* mine (21), located three-fourths of a mile southwest of the Weldon and 1 mile southeast of c Woodport, in Jefferson township, Morris county, is one of the largest deposits of ore in the state. Like all the large mines, it is an old one. It is the property of the Hurd heirs, and is worked under lease by the Glendon Iron Company. The ore is used in the Glendon furnaces, in Pennsylvania. From January 1, 1870, to December 31, 1878, over 251,000 tons of ore were raised from the mine. The total production is estimated at over 500,000 tons. In the census year 29,232 tons of ore were mined. The mine was fully described in the *Geology of New Jersey*, 1868, but since the date of that report all the openings near the turnpike have been abandoned, and the present operations are in the deep mine only. The form of the ore-mass is that of an immense pod. The angle of pitch averages 32°. The height of the chute is about 90 feet; its width, at the present stope, is 35 feet, and it has been worked for a length of 1,600 feet. As described by the New Jersey geologists, the surface-workings (now covered d up) clearly showed this ore-body to lie in the axis of a narrow synclinal fold, the bottom-rock being the inverted arch of the fold. (See Fig. 2, p. 5.)

The skip-road is laid on the bottom-rock. The walls are nearly vertical, except near the bottom of the shoot, where they gradually approach each other and form the bottom-rock. Along the upper ridge of the shoot the ore is lean, and is left in arch-form to support the roof. The walls are solid, requiring only an occasional pillar and no timbering. Water is not troublesome. Altogether the conditions for winning the ore cheaply appear to be most favorable. The Hurdtown is one of the few New Jersey mines worked without interruption from 1873 to 1879. About 30,000 tons of ore were stocked at the mine in April, 1880. The ore is as a rule coarsely granular; much of it is "shotty". It has a blue-black color, metallic to submetallic luster, and is generally free from foreign intermixture. Some specimens of the ore have an irridescent coating. A sample taken from 17 car-loads (about 110 tons) of ore ready for shipment yielded on complete analysis— e

	No. 318.		No. 318.
	Per cent.		*Per cent.*
Sulphur	0.169	Titanic acid	0.14
Phosphorus	0.196	Carbon in carbonaceous matter	0.03
Iron, metallic	66.02	Hygroscopic water	0.05
Phosphorus in 100 parts iron	0.255	Water of composition	0.24
		Total	99.793
Silica	4.06		
Iron, protoxide	29.78	Per cent. insoluble silicious matter	5.36 f
Iron, peroxide	61.13		
Alumina	1.73	Silica	4.06
Manganese, protoxide	Trace.	Alumina	0.17
Lime	1.29	Lime	0.27
Magnesia	0.43	Magnesia	0.17
Iron, disulphide	0.144	Potassa	0.03
Potassa	0.03	Soda	0.09
Soda	0.09	Iron, protoxide	0.58
Carbonic acid	0.26		
Phosphoric acid	0.389	Total	5.37

a The *Sickles* mine (22), in Sparta township, Sussex county, 2½ miles south of the village of Sparta, was opened in 1870. It is now leased by the Blooming Ridge Iron Company. All recent work has been done in a shaft 500 feet southwest of the old mine, which was abandoned, as the ore there lies in thin seams between seams of rock; and it did not pay to mine it. The new shaft is 60 feet deep. At the bottom of the shaft the vein of ore is 3 to 4 feet wide. A sample of the ore from a pile of about 50 tons at the top of this shaft contained—

b

	No. 319.
	Per cent.
Metallic iron	38.11
Sulphur	0.976
Phosphorus	0.050
Phosphorus in 100 parts iron	0.131

The total product of the mine is reported at about 4,000 tons. In the census year 1,000 tons of ore were raised. This latter was shipped to Stanhope and Secaucus, and was partly used for Bessemer metal.

Continuing in a southwesterly direction, the next mine sampled was the *Wright* or *Budd* mine (23), in Byram township, Sussex county, about 2 miles north from the village of Stanhope. Ore was discovered here about 5 years ago, and some work was then done toward developing the property. Work was resumed in October, 1879, by Smith and Ruslin. When visited three shafts had been sunk to depths of 55, 60, and 30 feet, respectively. The deepest shaft is between the other two. The strike of the ore is north 50° east; the dip is 30° to southeast. The c wall-rock is much decomposed near the surface, and the ore, too, is partially peroxidized and has a reddish color. The middle and the northeast shafts have passed through the "red ore" into a hard "blue" ore, containing much pyrite. To determine the effect of the partial oxidation on the sulphur and phosphorus in the ore, two samples were taken, one of the "red" and one of the "blue" ore. Below are the results of their analyses:

d

	No. 323.	No. 324.
	Per cent.	*Per cent.*
Metallic iron	49.88	47.62
Phosphorus	0.342	0.521
Sulphur	1.382	2.824
Phosphorus in 100 parts iron	0.685	1.094

Sample No. 323 was taken in the mine, from a breast of "red" ore; sample No. 324 is from a few tons of "blue" ore from the northeast shaft.

The ore is shipped to the Chestnut Hill furnaces in Pennsylvania. In the census year 2,016 tons of ore were mined. The total yield of the mine is estimated at 5,600 tons. William Wright is the owner of the property.

Southwest of the Wright mine, and about 1 mile north from Stanhope, is a ridge or hill, locally known as Mine hill. The western, southern, and southeastern slopes of the hill are completely honeycombed with small openings. These openings collectively go by the name of the *Hude* or *Stanhope* mine (24). The tract of land is owned by the Dickerson estate. The mine was worked in the census year by John M. Barnes. Two samples of the ore were e collected. They contained—

	No. 321.	No. 322.
	Per cent.	*Per cent.*
Metallic iron	49.95	50.23
Sulphur	0.178	1.220
Phosphorus	0.037	0.057
Phosphorus in 100 parts iron	0.074	0.113

Sample No. 321 represents ore from a small opening on the west side of the hill. The ore was much weathered. Sample No. 322 is from a pile of about 500 tons of ore at Stanhope furnace. The ore came from various openings, f but principally from the large pit on the east side of the hill. The ore from this pit is an unaltered magnetite and contains much pyrite.

During the census year 2,887 tons of ore were mined; it was shipped mainly to Stanhope. The total yield of the mine is estimated at 29,000 tons.

Passing southwestward along the ridge west of the Musconetcong valley, samples were taken from the *Egbert* and *Bald Pate* mines, in Mansfield township, Warren county, about 4 miles southwest from Hackettstown, and near Mount Bethel.

The *Egbert* mine (25) has been idle since 1876. Previous to that year several thousand tons of ore were mined, and about 100 tons were stocked at the mine when visited. The vein is reported to have been worked to a depth

of 130 feet and a length of 215 feet. Nothing definite could be learned in regard to the width of the ore, and the mine was of course filled with water. The ore contains a great deal of pyrite. The analysis of the sample shows— a

	No. 100.
	Per cent.
Metallic iron	47.37
Phosphorus	0.418
Sulphur	4.010
Phosphorus in 100 parts iron	0.882

The *Bald Pate* mine (26) is one-half mile southwest of the Egbert. It had produced, up to 1876, 2,000 tons of ore. From 1876 to 1879 the mine was idle; but it was reopened in the fall of the latter year by H. J. Boardman. About 150 tons of ore were raised, when work was again stopped. When visited, in February, 1880, the shafts were filled with water. A sample was taken from a pile of about 75 tons of ore near the top of one of the shafts. Much of the material in the pile was fine and earthy. The sample contained— b

	No. 99.
	Per cent.
Metallic iron	54.10
Phosphorus	0.039
Sulphur	0.025
Phosphorus in 100 parts iron	0.072

c

The *Oxford Furnace* mines (27) are located at Oxford Furnace, in the northeast corner of Washington township, Warren county, on the north slope of a spur of Scott's mountain. Ore was mined here before 1743, as in that year a blast-furnace was put in operation near the mines. The mines are, therefore, among the oldest in the country. They are owned by the Oxford Iron Company. Their total product is not known, but from 1869 to 1877 the average annual yield was about 23,000 tons of ore. In the census year 22,359 tons of ore were produced. Near the mines, and under the same management, are two blast-furnaces and a nail-mill. All the iron in the ore is turned into nails within a mile of the mines. As shown by the accompanying sketch (Fig. 53), several veins of ore on the property have been wrought. Though not parallel, three of the veins worked have a general northwest and southeast trend, thus differing from the usual course of New Jersey iron-ore deposits. In this they conform, however, to the stratification of the inclosing gneiss. d e

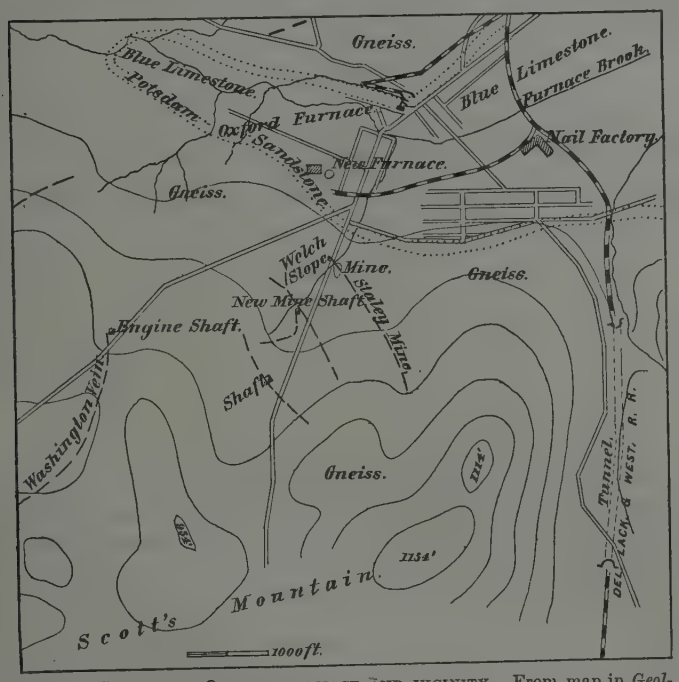


FIG. 53.—SKETCH OF OXFORD FURNACE AND VICINITY. From map in *Geology of New Jersey*, 1868.

The *Staley* mine is the most northerly of the group. The vein of ore is now believed to be exhausted.

About 700 feet southwest of the Staley shaft is the *New Mine* shaft, and 400 feet northwest of the latter the Welch slope is situated. The ore from two veins is raised through each opening. In the New mine the veins are called the "Car-wheel" or "red-ore" vein, and the "New Mine" or "gray-ore" vein; and in the Welch mine they go by the names of the "Welch vein" and the "Slope vein". It is believed that the slope is the extension of the Car-wheel vein, and the Welch the continuation of the New Mine vein. But the continuity of both veins is interrupted by a "crossing" of feldspathic (orthoclase) rock, and possibly, too, by a fault. f

The New mine shaft is sunk near the foot-wall of the Car-wheel vein; it is about 250 feet deep. A plan of the mine, some 25 feet above the present level, from a survey made by Mr. William Scranton, is given in Fig. 54.

This plan shows the veins to be separated by from 15 to 25 feet of rock. West of the bottom of the shaft, that is, in a direction toward the Welch mine, the ore in each vein is cut off by rock. This rock pitches rapidly toward the east, and will probably be cut by the shaft at another level. East of the shaft the "gray-ore" vein has been

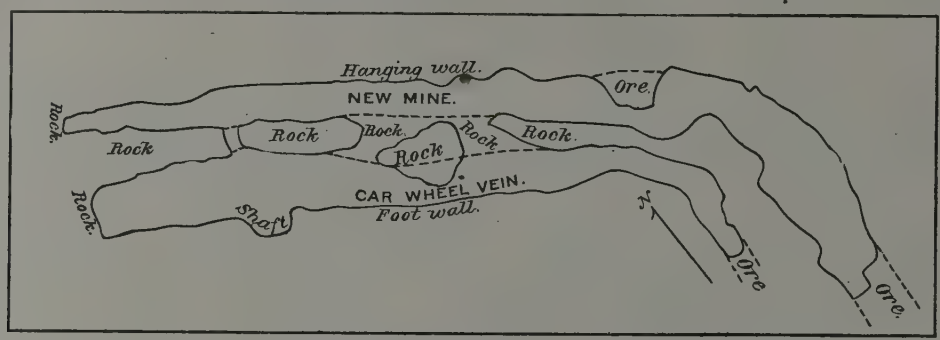
a worked at the level of the sketch for a length of 330 feet, and the Car-wheel vein for a length of 258 feet. The sketch is chiefly interesting as showing the bend in both veins. At the surface it would appear from the map that only the Car-wheel vein was bent, but at the level of the sketch both veins are bent, and continue, moreover, nearly parallel beyond the bend. Between the bottom of the mine and the surface the Car-wheel mine was in places 20 feet wide. It has narrowed, however, at the present stope to about 4 feet. The stope in the gray-ore vein is 20 feet wide. Samples were taken from each stope, and contained—

b

	No. 91.	No. 92.
	Per cent.	*Per cent.*
Metallic iron	54.84	39.54
Phosphorus	0.151	0.044
Sulphur	0.225	0.758
Manganese	Present.	Present.
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.275	0.111

Sample No. 91 is from the Car-wheel vein. The ore is a finely granular to compact magnetite, and has a peculiar purplish tinge of color. A hand specimen contained thin layers of calcite. Sample No. 92 is from the "gray-ore" vein. This ore is carefully hand-picked before it is sent to the furnace.

c



d

FIG. 54.—PLAN OF THE NEW MINE, NEAR OXFORD, NEW JERSEY. From surveys by Mr. William H. Scranton.

The ore from the two veins is not kept separate. Two samples were taken to show the run of the shipping product of the mine. These samples contained—

e

	No. 95.	No. 330.
	Per cent.	*Per cent.*
Metallic iron	43.31	46.66
Phosphorus	0.072	0.095
Sulphur	0.307	0.270
Manganese	Present.	Present.
Titanic acid	Present.	.....
Phosphorus in 100 parts iron	0.166	0.204

Sample No. 95 is from a pile of 75 tons of ore at the furnace. Sample No. 330 is supposed to be an average of a week's output of the mine. It was collected as follows: A barrel was placed near the road between the mine and the furnace, and teamsters were ordered by Mr. Scranton to throw half a shovelful of ore from each wagon-load into the barrel as they drove by. On the writer's return to the mine the barrel was full. He was told that it had taken about a week to fill it. Its contents were emptied onto the floor of the engine-house, and a sample was carefully taken from the pile.

f In the Welch mine but very little ore was seen. No work was being done in the slope vein, and the ore in the Welch vein was very much mixed with rock. Sample No. 94 was taken from a pile of 100 tons of the ore at the furnace, and sample No. 329 was obtained in a manner similar to sample No. 330. The samples yielded on analysis—

	No. 94.	No. 329.
	Per cent.	*Per cent.*
Metallic iron	46.59	41.60
Phosphorus	0.077	0.059
Sulphur	0.342	0.585
Manganese	Present.	.....
Titanic acid	Present.	.....
Phosphorus in 100 parts iron	0.165	0.142

The *Washington* mine is about two-thirds of a mile southwest from the Welch slope. It was originally opened a some twenty-six years ago; but it was abandoned after being worked for twelve years, because the ore was too pyritiferous to be used in the furnace. Work was begun toward reopening the mine in the autumn of 1879. When visited in February, 1880, actual mining had just been resumed. The shaft in use is west of the road, and is 95 feet deep. From this shaft a long line of magnetic attraction extends in a southerly and southeasterly direction. There are numerous old openings along this line, and a new shaft was started in November, 1879, 1,100 feet southeast of the working-shaft, after a careful magnetic survey had been made of the property by Mr. William Scranton. (*a*) At the present stope, 75 feet southeast from the shaft, the vein is 8 feet wide; it dips toward the north at an angle of about 45°. The following analyses show the character of the ore:

b

	No. 90.	No. 93.
	Per cent.	*Per cent.*
Metallic iron	57.43	61.36
Phosphorus	0.505	0.657
Sulphur	0.620	0.609
Manganese	Present.	Present.
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.579	1.070

Sample No. 90 was taken across the stope in the mine, and sample No. 93 from a pile of 75 tons of the ore at the furnace. Lumps of ore containing a great deal of pyrite are sorted out; hence sample No. 93 is lower in c sulphur than is the "run" of the mine.

Returning to near the foot of Lake Hopatcong:

The *Gove* mine (28), in Roxbury township, Morris county, 1 mile northwest of Drakesville station, was opened in 1874. It was reopened in October, 1879, and produced in the census year 3,920 tons of ore. The total yield is estimated at 11,200 tons. The mine is owned and operated by Francis N. Gove. The ore is shipped to the Colerain furnace, Lehigh valley, Pennsylvania. It was not sampled.

The *High Ledge* mine (29) and the *King* mine, both near Drakesville, were worked for a few months in the census year. The product was 1,120 tons of ore from the former and 280 tons from the latter. The mines were idle when visited and the ore was not sampled.

Extending in a southwesterly direction from a point about 2 miles southwest of Drakesville is a long line of d magnetic attraction which has been opened upon in numerous places. As a rule only narrow veins of ore were discovered, and very little work has been done along the range in recent years. In January, 1880, however, the *Mount Olive* mine (30), near the village of Mount Olive, in Mount Olive township, Morris county, was reopened by William E. George & Co., and worked until May; 1,625 tons of ore were produced. The total yield of the mine is estimated at 22,400 tons. There are several old shafts on the property. The one in use is 165 feet deep. At the bottom of the shaft the vein is 6 to 8 feet wide. The ore at this depth is a hard blue magnetite and contains much pyrite. A sample from 600 tons at the shaft yielded on analysis—

e

	No. 326.
	Per cent.
Metallic iron	58.92
Sulphur	1.960
Phosphorus	0.182
Phosphorus in 100 parts iron	0.309

Northeast of the above-mentioned shaft a new shaft is being sunk. When visited it was 35 feet deep. It had passed through 8 feet of surface material, 22 feet of soft, partially oxidized ore, and was bottomed in a hard blue ore. A sample from a pile of 75 tons of the partially oxidized ore contained—

f

	No. 327.
	Per cent.
Metallic iron	63.36
Sulphur	0.145
Phosphorus	0.090
Phosphorus in 100 parts irom	0.142

The *Stoutenburgh* mine (31) is located on Schooley's mountain, in Washington township, Morris county, about 3½ miles from Hackettstown. A mine was opened on the property in 1872 and about 6,700 tons of ore were mined.

a A map of this survey was published in the *Annual Report of the State Geologist* for 1879.

a Owing to the vein pinching out the mine was abandoned in 1873. In 1877, Mr. Stoutenburgh resumed prospecting for other veins and sunk numerous test-pits. The present workings are 350 feet southwest of the old mine. There are two shafts 35 feet apart, the one 90 the other 64 feet in depth. The vein at the bottom of the workings is reported to be 3 feet in width. The mine is very wet, and when visited was partly filled with water, and no mining was being done. New pumping machinery is about to be put in. A sample was taken from a pile of 50 tons of the ore at the mine, and yielded on analysis—

b

	No. 328.
	Per cent.
Metallic iron	56.37
Sulphur	0.155
Phosphorus	0 639
Phosphorus in 100 parts iron	1.134

The ore is red in color and is mottled. The mottling is possibly produced by the partial removal of crystals of apatite. During the census year 1,680 tons of ore were raised. The mine is leased by Joseph Wharton. The ore is used at the Hackettstown furnace.

About 2 miles southwest of the Stoutenburgh mine, William W. Marsh did some exploring in the spring of 1880 near the *Hann* mine (32), and raised about 150 tons of ore from a new opening.

c The *Gray* mine (33), near Whitehall, Lebanon township, Hunterdon county, was worked the greater part of the census year by the Saucon Iron Company; 1,940 tons of ore were produced. The total yield of the mine is estimated at 8,400 tons.

The *Pidcock* and *Eveland* mines, also in Lebanon township, were worked for a short time in the spring of 1880, producing 156 and 224 tons of ore, respectively.

The *Mayberry*, *Asbury*, *Rodenburg*, *Case* and *Petty* mines, all in Bethlehem township, Hunterdon county, were worked for about a month in the census year, and produced altogether a little less than 500 tons of ore.

The *Church* or *Van Syckle's* mine (34), on John T. Leigh's farm, in Bethlehem township, near Valley station, on the Central railroad of New Jersey, although not worked since 1876, is mentioned here because the ore is reported to contain a large percentage of titanium. A mean of ten analyses is reported to show the presence of over 12 per d cent. of titanic acid—the extremes being 9.82 per cent. and 15.05 per cent. The mine was opened in 1871, but was abandoned, after 4,390 tons of ore had been mined, as the ore was too difficult to smelt. Titanic acid is commonly present in the New Jersey magnetites, but, so far as I know, this is the only locality where it has been found in such quantities as to render the ore unfit for use.

The *Swayze* mine, also near Valley station, was reopened in November, 1879, by the West End Iron Company. No ore was, however, raised before the end of the census year.

The *Turkey Hill* or *West End* mines (35), near Bethlehem, Bethlehem township, Hunterdon county, were opened in 1872. During the census year 11,086 tons of ore were mined. There are two parallel veins of ore on the property, but thus far the west vein has alone been worked to any extent. The strike of the veins is north 75° east, and the dip is about 60° toward the southeast. Seven shafts have been sunk: No. 1 is at the southwest end of the mine e and on higher ground than the others; it is 90 feet deep. No. 2 is 630 feet beyond No. 1; it is 163 feet deep. Between shafts Nos. 1 and 2 there is a small strip of land which is being explored by Daniel Runkle. Shaft No. 3 is 380 feet northeast of No. 2, and No. 4 is 340 feet beyond No. 3. No. 3 is 175 feet deep and No. 4 is 235 feet deep, and these two shafts are connected by underground workings. Pits Nos. 1 and 2 are separate. Shaft No. 5 is 600 feet beyond No. 4 and is 140 feet deep; No. 6 is 2,400 feet northeast of No. 5, and shaft No. 13 is about midway between Nos. 5 and 6. In May, 1880, no ore had been raised from shafts Nos. 5, 6, and 13, and shaft No. 2 had been idle for two or three years. On account of a strike of the miners the whole mine was temporarily idle when visited, and I was unable to go through it; but according to the report of the state geologist for 1879 the ore varies in thickness from 6 to 20 feet, this variation being caused by rolls in the foot-wall.

Samples were taken of the ore from shafts Nos. 1, 3, and 4. The samples contained—

f

	No. 331.	No. 332.	No. 333.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	35.31	30.45	52.48
Phosphorus	0.006	0.000	0.004
Sulphur	0.126	0.034	0.013
Phosphorus in 100 parts iron	0.017	0.000	0.008

Sample No. 331 is from shaft No. 1, No. 332 is from shaft No. 3, and No. 333 is from shaft No. 4. The ore is a finely-granular magnetite, with hornblende, brown mica, a little calcite (in thin layers), and occasionally a speck of pyrite. As it comes from the mine it has a grayish color. Sample No. 332 is unique among New Jersey ores in containing no phosphorus.

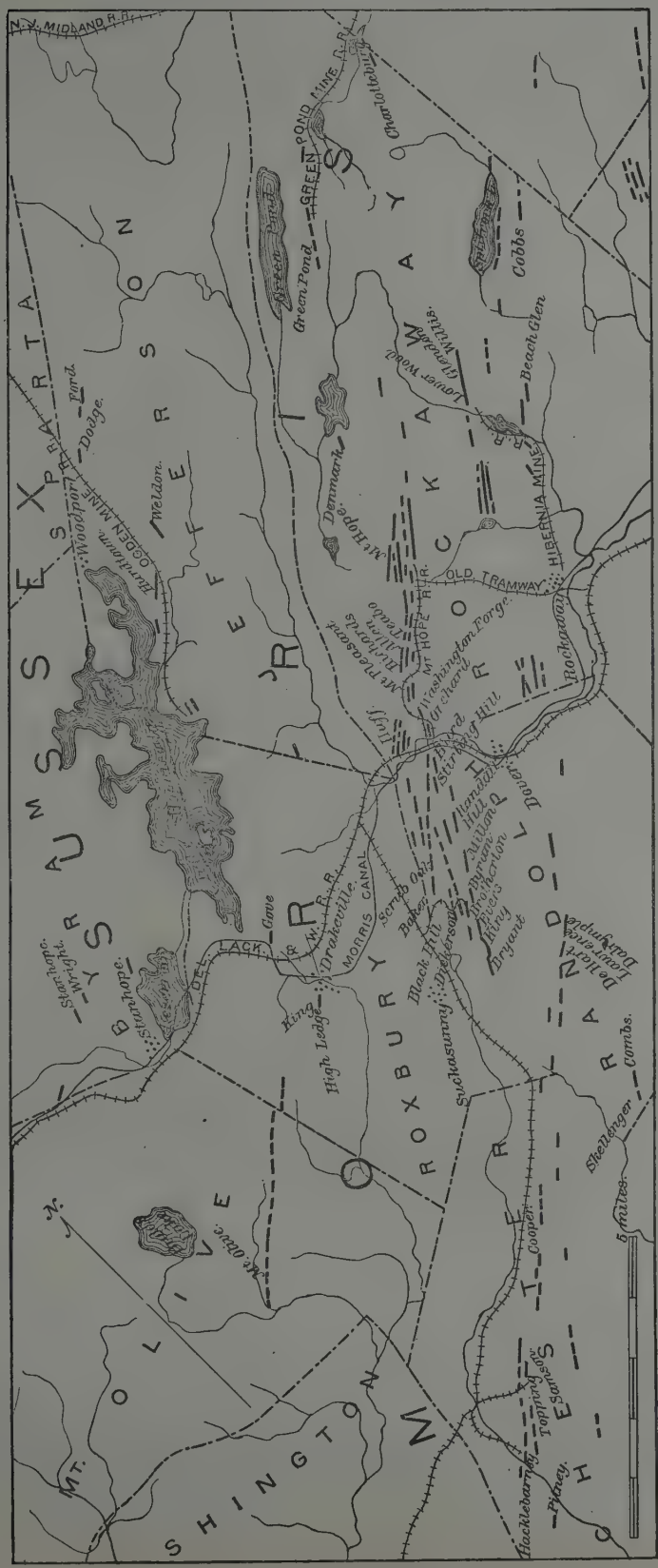


FIG. 55.—MAP OF A GROUP OF IRON MINES NEAR DOVER, NEW JERSEY. From a map of "Northern New Jersey" published by the New Jersey Geological Survey in 1874.

a The *Hager* mine (36), in Holland township, Hunterdon county, 1¼ miles west of Spring Mills, and on the Musconetcong mountain, was worked during the census year by the Holland Mining Company. About 800 tons of ore were raised. The total yield of the mine is estimated at 1,680 tons. Early in May, 1880, the shafts described in the *Annual Report of the State Geologist for* 1879 had been temporarily abandoned on account of water, and a new shaft had been started northeast of the old mine. This shaft was 20 feet deep, and it had uncovered two narrow veins of ore separated by 2 feet of rock. One of the veins is 2 feet and the other 4 feet wide. A sample was taken from a few tons of ore at the top of the shaft. It contained—

b

	No. 334.
	Per cent.
Metallic iron	62.71
Phosphorus	0.274
Sulphur	0.093
Phosphorus in 100 parts iron	0.437

The ore is nearly all soft, owing to partial decomposition. In the deeper shafts a hard, blue, pyritous ore was reached.

The Hager completes the list of working mines in the Musconetcong belt.

c

PASSAIC BELT.

Large's mine, in Clinton township, Hunterdon county, was worked one month in the census year and produced about 100 tons of ore. The *Annandale* mine, in High Bridge township, was in operation two months; 625 tons of ore were raised. The mines were not sampled.

The old *High Bridge* mines (39), worked early in the last century, are located north of the village of High Bridge. The ore occurs in small independent shoots, and the old workings extend in a northeast and southwest direction for about half a mile. The western end of the vein or line of shoots belongs to John Kane and the eastern end to the Thomas Iron Company. The deeper workings are now filled with water, but during the census year about 2,000 tons of ore were mined, above the water-line, in the Taylor opening, on the Thomas Iron
d Company's property. A sample was taken from a few tons of ore which had come from this pit. The sample yielded on analysis—

	No. 335.
	Per cent.
Metallic iron	55.15
Phosphorus	0.609
Sulphur	5.172
Phosphorus in 100 parts iron	1.104

e The ore is partly covered with an efflorescence of sulphate of iron.

The *Silverhorn* or *Kane* mine and the *Cregar* mine, both in High Bridge township, were worked for a short time in the census year, and about 250 tons of ore were raised at each locality. Some exploratory work was also done at the *Old Furnace* mine, but no ore was produced.

After considerable exploring a mine has recently been opened by Cooper & Hewitt on the *Pitney* farm (38), in Chester township, Morris county, near the Black river, and about a mile and a quarter from Hacklebarney. In the census year 2,800 tons of ore were produced. The total yield of the various openings on the property is estimated at 6,700 tons. The ore thus far mined is much decomposed. It is reddish in color, and is quite soft and earthy. It is usually washed before it is shipped. A sample taken at the mine from a pile of about 25 tons of washed ore contained—

f

	No. 346.
	Per cent.
Metallic iron	50.84
Phosphorus	0.112
Sulphur	0.142
Phosphorus in 100 parts iron	0.220

The *Hacklebarney* mine (39), in Chester township, consists of fourteen or fifteen shallow pits, mostly open cuts, located on both sides of the Black river. Ore was mined at this locality in the last century, and the mine has been worked quite steadily for many years. In the census year over 31,000 tons of ore were produced. The mine is owned and operated by the Chester Iron Company. The ore is shipped to different Pennsylvania furnaces.

On the hill southwest of the river there are three openings. Two of these are open pits, 135 feet long by 40 feet wide, and 45 feet deep, on the same vein of ore. The vein is worked to a width of from 25 to 35 feet, but less than one-half of this width is merchantable ore. About 100 feet west of the above pits is a narrow vein of ore which is being exploited by underground mining. The shaft is 125 feet deep, and the ore is 4 to 6 feet wide. Samples were collected from piles containing about 400 tons of ore from each of the open pits, and 100 tons of ore from the shaft. These samples were carefully mixed after being pulverized. The following analysis of the united samples indicates, therefore, the run of the ore from the southwest hill: a

	Nos. 336, 337, and 338.
	Per cent.
Metallic iron	47.21
Phosphorus	0.098
Sulphur	3.290
Phosphorus in 100 parts iron	0.207

The ore contains a large per cent. of green mica, which gives to it a highly developed schistose structure. Pyrrhotite is present in abundance.

The coal-house pit is at the foot of the hill on the west side of the river. It is probably 50 feet deep and 25 to 30 feet wide. Near the surface the ore is decomposed, owing to the oxidation of the pyrite, but at the bottom of the pit it is a hard, granular magnetite, with green and brown mica, hornblende, and pyrrhotite. The surface-ore is washed. Sample No. 339 is from 75 tons of ore from the bottom of the pit, and sample No. 345 is from 20 tons of the washed surface-ore. The samples contained— c

	No. 339.	No. 345.
	Per cent.	*Per cent.*
Metallic iron	56.59	48.38
Phosphorus	0.025	0.057
Sulphur	3.653	0.529
Phosphorus in 100 parts iron	0.044	0.118

d

Opposite the coal-house pit, on the northeast side of the river, two cuts have been driven into the hillside. In the larger of these, known as the Andrew's open cut, the ore has been in places 25 to 30 feet in width. But the walls are very irregular. Immediately east of the Andrew's cut is the "East cut", on a smaller but parallel vein of ore. Samples were taken from piles of ore from each opening. The united samples yielded on analysis—

	Nos. 340 and 341.
	Per cent.
Metallic iron	52.00
Phosphorus	0.048
Sulphur	3.763
Phosphorus in 100 parts iron	0.092

e

On the hill northeast of the river samples were taken of ore from the Tunnel vein, the George vein, and the Foley vein. An average of three samples contained—

	Nos. 342, 343, and 344.
	Per cent.
Metallic iron	46.47
Phosphorus	0.075
Sulphur	3.517
Phosphorus in 100 parts iron	0.161

f

The Tunnel and Foley openings appear to be on a line with the Andrews' open cut, while the George vein is several hundred feet east of this line. The veins are narrow and are worked underground. In the George mine the shoot of ore pitches toward the northeast at an angle of about 30°. The ore is 4 to 5 feet wide. The mine is the most northerly opening on the property, and is distant nearly a half mile from the Andrews open cut at the river.

a The *Topping* mine (40), in the village of Chester, near the depot, was worked for several months in the spring of 1880 by W. J. Taylor & Co. About 875 tons of ore were raised. The ore was used in the Chester furnace. Numerous openings have been made on the property; the ore at present worked is about 30 feet deep. The ore is all soft "surface" ore, but it is used in the furnace without washing. A sample from a pile of 75 tons contained—

	No. 348.
	Per cent.
Metallic iron	55.84
Phosphorus	0.086
Sulphur	0.000
Phosphorus in 100 parts iron	0.154

b

The *Samson* mine (41), on property adjoining the Topping farm, was reopened in January, 1880, by Cooper, Hewitt & Co. It produced 3,360 tons of ore in the census year. The mine was first opened in 1867, and has yielded a total of 39,200 tons. The Samson Mining Company is the owner. Near the surface the ore was of the same character as that now mined on the Topping farm, but at the present depth, 180 feet, the ore is a hard, blue magnetite, carrying a large percentage of magnetic pyrite. The mine is opened for a length of 350 feet. A sample taken from a pile of 1,000 tons of the ore contained—

c

	No. 349.
	Per cent.
Metallic iron	51.39
Phosphorus	0.097
Sulphur	4.158
Phosphorus in 100 parts iron	0.188

The *Cooper* mine (42) is located about 1 mile northeast of the village of Chester, on the farm of the late Nathan A. Cooper. It was opened by the Cooper Mining Company in December, 1879. Before the close of the census year 5,860 tons of ore were shipped from the mine. The ore thus far mined is all "surface" ore; it is washed before it is shipped away. A sample from a few tons of washed ore contained—

d

	No. 350.
	Per cent.
Metallic iron	62.89
Phosphorus	0.156
Titanic oxide	Present.
Phosphorus in 100 parts iron	0.248

The *Combs'* mine (43), in Randolph township, Morris county, 1½ miles southwest of Walnut Grove, on lands of J. Combs and J. Styles, was worked in part by E. Canfield and in part by Fitzgerald & Scofield during the census year. Canfield worked the northwestern part of the vein—the portion on Combs' property—and raised 4,480 tons of ore e in the census year. The vein is quite regular. It has a north 50° east strike, a dip to the southeast of about 40°, and is 9 to 10 feet thick. It has been opened for a length of 500 to 600 feet and to a depth of over 100 feet. The present workings are 50 to 60 feet below surface.

On the Styles property about 1,000 tons of ore were mined during the winter of 1880, and were stocked at the mine when visited. A sample from this pile contained—

	No. 351.
	Per cent.
Metallic iron	37.15
Phosphorus	0.036
Titanic oxide	Present.
Phosphorus in 100 parts iron	0.097

f

Immediately south of the road, and about an eighth of a mile from the Combs mine, a shaft was sunk in 1878 on the Skellenger farm. In the census year Mr. Canfield worked this pit and produced 4,480 tons of ore. The total yield of the mine is 9,840 tons. The ore is similar to that from the Combs mine, and a separate sample of it was not taken. The product of the Combs and Skellenger mines is used for Bessemer pig by the Lackawanna Iron and Coal Company.

The *De Hart* (43), *Lawrence* (44), and *Dalrymple* (45) mines, in Randolph township, Morris county, 4 miles south of Dover, form nearly continuous openings for a distance of about a quarter of a mile. The De Hart is the southernmost mine of the group. It is worked by one shaft to a depth of 100 feet. The vein is 3 feet wide. The

a Lawrence adjoins the De Hart on the northeast and has three shafts. The only work being done at the mine in May, 1880, was in sinking shaft No. 1—the northeast shaft. It is about 115 feet deep, and at the bottom the vein is not more than 2½ feet wide. In descending the shaft the greatest width observed between the walls was about 4 feet. Samples taken from a few tons of ore from each mine contained—

	No. 354.	No. 355.
	Per cent.	*Per cent.*
Metallic iron	50.70	51.62
Phosphorus	0.633	0.246
Titanic oxide	Present.	Present.
Phosphorus in 100 parts iron	1.248	0.477

b

Sample No. 354 is from the De Hart mine; sample No. 355 is from No. 1 shaft of the Lawrence mine.

The mines were reopened in November, 1879, by the Reading Iron Company. In the census year the product of both mines was 760 tons of ore.

The *Dalrymple* mine was reopened by the Crane Iron Company in September, 1879. It produced 2,650 tons of ore before the close of the census year. The ore was shipped to Catasauqua, Pennsylvania. There are two groups of workings on the property. Shaft No. 9 is near the Lawrence mine; it is 180 feet deep. Pit No. 5 is several hundred feet northeast of shaft No. 9. It is entered by two shafts, and has been worked to a depth of nearly 300 feet. The vein dips at an angle of 75° to 80°, and the ore varies in thickness, owing to the rolls in the walls, from c 18 inches to 5 feet. The ore separates from the walls readily, leaving them remarkably smooth and well defined. Sample No. 356 is from a pile of 20 tons of ore from shaft No. 9; sample No. 357 is from a few tons of ore from pit No. 5. The samples contained—

	No. 356.	No. 357.
	Per cent.	*Per cent.*
Metallic iron	59.54	55.92
Phosphorus	0.366	0.222
Titanic oxide	Present.	Present.
Phosphorus in 100 parts iron	0.615	0.397

d

The *Bryant* mine (46), in Randolph township, Morris county, is on the southern end of a long range upon which are located many of the principal iron mines of New Jersey. The mine has been worked for the past five years by John D. Evans, and has produced in that time 22,400 tons of ore. The production in the census year was 6,720 tons. Two shoots of ore are worked on the property. The largest of these averages 20 feet in height, 7 to 8 feet in width, and has been worked for a length of about 700 feet. The slope is designated No. 1. The ore from the other shoot is raised through shaft No. 2, which is 175 feet deep. Samples of the ore from each shoot contained—

	No. 352.	No. 353.
	Per cent.	*Per cent.*
Metallic iron	63.24	50.70
Phosphorus	0.038	0.025
Titanic oxide	Present.	Present.
Phosphorus in 100 parts iron	0.060	0.049

e

Sample No. 352 is from slope No. 1; sample No. 353 is from shaft No. 2. The ore is used by the Bethlehem Iron Company for Bessemer steel.

The *King* mine (47), 1 mile northeast of the Bryant, was worked for a few months in the census year, and 2,560 tons of ore were raised. When visited in May, 1880, the pumps had been taken out and the mine had been abandoned.

The *Evers* mine (48), northeast of the King, was worked throughout the census year by the Saucon Iron Company. f The ore was shipped to Hellertown, Pennsylvania. In the census year 2,500 tons of ore were produced, all of which was mined quite near the surface, the deeper workings not having been pumped out. The ore is teamed to McCainsville, and there loaded on the cars. A sample from the cars contained—

	No. 358.
	Per cent.
Metallic iron	47.86
Phosphorus	0.086
Titanic oxide	Present.
Phosphorus in 100 parts iron	0.180

a The *Brotherton* mine (49), adjacent to the Evers, was reopened by Messrs. George & Pullman in August, 1879, and worked until June 1, 1880. It produced 4,730 tons of ore. The ore was raised from five shafts, the deepest of which is 130 feet. A slope on the premises, which is reported to be over 200 feet in depth, was not freed from water. The ore lies in two narrow veins, and as it comes from the mine it is largely mixed with rock. It has to be carefully cobbed over before it is shipped. A sample of the ore from the cars at McCainsville contained—

b

	No. 359.
	Per cent.
Metallic iron	50.98
Phosphorus	0.214
Titanic oxide	Present.
Phosphorus in 100 parts iron	0.420

The *Byram* mine (50) is the next in order. It is owned and worked by the Andover Iron Company. In the census year 16,605 tons of ore were mined. It was used in the company's furnaces at Phillipsburgh. The present operations on the property form two distinct mines. Of the southwest mine or group of workings, shaft No. 7 is near the road; northeast of this is No. 8, then No. 12, and lastly No. 6, the latter being near the engine-house. Shafts Nos. 6, 8, and 12 are on one and the same shoot, and are connected underground. Shaft No. 7 is on a chute about 18 feet west of the ore first mentioned. Shafts Nos. 6 and 8 are about 300 feet deep. The vein is very much broken up by small faults or "throws". It varies in width from 3 to 5 feet. When visited no ore was being raised c from shaft No. 8, but samples were taken from several tram-car loads of cobbed ore from the three other shafts. The samples contained—

	No. 360.	No. 361.	No. 362.	No. 363.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	38.52	28.24	40.70	59.54
Phosphorus	0.393	0.605	0.790	0.245
Titanic oxide	Present.	Present.	.....	.....
Phosphorus in 100 parts iron	1.020	2.142	1.940	0.441

d Sample No. 360 is from shaft No. 7; No. 361 is from shaft No. 12; Nos. 362 and 363 are from shaft No. 6. The stope in pit No. 6 is 3 or 4 feet wide, and about 18 inches of the vein-matter is a partially decomposed hornblende (?) schist. This does not lie in one solid body by itself, but is interlaminated between layers of magnetite. The greater proportion of the ore from this pit is in the form of an earthy powder. Near the hanging-wall there is, however, a seam of coarsely granular magnetic ore, between 4 and 8 inches thick, which has a well-developed cubical fracture. Sample No. 362 represents an average of the run of the pit, from a few tons of ore at the top of the shaft. Sample No. 363 is a special sample of this band of rich ore.

The northwest workings comprise two slopes, known as the old Byram slope and the Russell slope, 700 and 800 feet long, respectively. The slopes follow the foot-wall of the vein, which dips at an angle of 50° to the southeast. The Russell mine has been idle for some months, owing to the great influx of water, which the pumps e have been unable to keep down. When visited on May 21, some work was being done toward sinking the old Byram slope. At that time the superintendent expected to have the Russell mine in operation the following week, and the sampling of the mine was therefore left till another visit. Unfortunately the engine-house burned down a day or two afterward, and the water soon rose and stopped all work in the old Byram mine also. In the following week no work was being done in either of these deep pits, with the exception of robbing a pillar located about 400 feet down the slope of the old Byram mine. A sample of the ore from this pillar contained—

f

	No. 364.
	Per cent.
Metallic iron	57.75
Phosphorus	2.110
Phosphorus in 100 parts iron	3.653

The ore is very coarsely granular, and contains a very large per cent. of apatite. Part of a specimen is over one-third (by volume) granular apatite.

The ore from the several shafts of the Byram mine is run to the bottom of the hill on tram-cars by gravity. The empty cars are drawn back by mules.

The *Millon* mine (51), northeast of the Byram, was reopened in February, 1880, by the executors of the estate of James C. Lord. The mine belongs to the estate. Before the close of the census year 1,263 tons of ore were

raised. There are two shafts to the mine. The hoisting shaft is about 255 feet deep. The vein is said to vary a from 2 to 5 feet in width. A sample of the ore from several car-loads contained—

	No. 365.
	Per cent
Metallic iron	43.73
Phosphorus	0.583
Phosphorus in 100 parts iron	1.333

The *Randall Hill* mine (52) is worked by the Crane Iron Company. Its production in the census year was 8,360 tons of ore. The ore is used at Catasauqua, Pennsylvania. The vein has ranged from 2 to 8 feet in thickness, b and has been worked in one slope to a depth of 700 feet on a dip of 45° to the southeast, and in the other slope to a depth of 300 feet. Between the two slopes there is a right hand throw of 21 feet. At the deepest part of the mine the vein is 3 to 3½ feet wide. The ore is teamed to the cars at McCainsville. A sample of the ore from the cars contained—

	No. 366.
	Per cent.
Metallic iron	44.51
Phosphorus	0.577
Phosphorus in 100 parts iron	1.296

c

The *Dickerson* (53), west of the Byram, and about half way down the hill, is one of the largest as well as one of the oldest mines in the state. It is owned by the Dickerson-Suckassunny Mining Company, and is operated under royalty lease by A. Pardee. The ore is used in the Musconetcong Iron Company's furnaces at Stanhope, and in different parts of Pennsylvania. In the census year the mine produced 28,900 tons of ore. Its total yield is estimated at 896,000 tons. The ore lies in three parallel shoots, known as the "Main vein", the "Side vein", and the "Cowbelly vein". These shoots all pitch to the northeast. The angle of pitch, taken on the skiproad in the "Main vein", varies from 35° to 48°. The "Main vein" has been worked for a length of nearly 1,000 feet, or to a vertical depth of over 600 feet. The workings in the "Side vein" are about 400 feet, and those in the "Cowbelly vein" about 500 feet, below surface. When visited the "Cowbelly vein" was full of water, and no work was being done in it. Samples were taken of the ore from the "Side vein", and from the main stope, and also from the sink d in the "Main vein". The samples yielded on analysis—

	No. 367.	No. 368.	No. 369.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	61.62	65.17	63.63
Phosphorus	1.186	0.282	0.178
Phosphorus in 100 parts iron	1.924	0.433	0.279

Sample No. 367 represents ore from the sink, "main vein" ("pit No. 11"); sample No. 368, ore from the main stope, near bottom of "main vein", and sample No. 369, ore from the "side vein". The samples were collected at e the ore-dock at the mine, from piles containing about 25 tons each. All the ore from the mine is a typical "shot-ore"; it is almost wholly in the form of fine material when it reaches the cars. In the mine the jointed structure of the ore-mass is seen to be highly developed. Apatite is present in quantities in all parts of the ore-bed.

The *Black Hill* mine (54), near the Dickerson, and belonging to the same company, was worked for a portion of the census year, and produced 2,195 tons of ore. The ore is said to be lean, but to run low in phosphorus. It has been used for Bessemer steel. The mine had been abandoned when visited.

The *Baker* mine (55) is situated at the foot of "Mine Hill" or "Mount Ferrum", a short distance northeast of the Dickerson mine. The mine has recently been bought by the Lackawanna Iron and Coal Company, and the ore, which, like the Black Hill ore, is comparatively free from phosphorus, is being used for Bessemer. In the census year 14,695 tons of ore were mined. The vein is reported to average from 8 to 9 feet in width. The present depth of the mine is about 165 feet. A sample of the ore taken from the cars at McCainsville contained— f

	No. 370.
	Per cent.
Metallic iron	32.02
Phosphorus	0.033
Phosphorus in 100 parts iron	0.103

The ore contains much quartz and feldspar. Owing to the decomposition of the latter the ore is soft near the outcrop.

a The *Scrub Oak* mine (56), northeast of the Baker, was reopened in February, 1880, by its owners, the Andover Iron Company, after having been idle for twelve years. Work was stopped in June, and the ore was not sampled. During the time the mine was in operation 1,680 tons of ore were produced. The ore is lean. The total yield of the mine is estimated at 56,000 tons.

Of the group of mines known as the Irondale mines, situated near Port Oram, 2 miles from Dover, the Sterling and the Hurd were worked during the census year by the Thomas Iron Company. The other mines were idle. The Irondale mines are owned by the New Jersey Iron Mining Company.

The *Sterling* mine (57) is located on the top of the hill, southwest of the village of Port Oram. The ore lies in a single shoot, which has been worked for a length of about 600 feet. The angle of pitch of the shoot is from 10° to 18°. The ore is 3 to 10 feet wide, and averages, perhaps, 6 feet in width. The mine yielded 16,800 tons of ore b in the census year. A sample taken from 5 car-loads (about 60 tons) of the ore contained—

	No. 371.
	Per cent.
Metallic iron	58.80
Phosphorus	1.342
Phosphorus in 100 parts iron	2.282

The *Hurd* mine (58) is situated at the foot of the hill, near the Morris canal. The working shaft of the mine c is about 300 feet deep. The vein varies from 4 to 7 feet in width. The mine is very wet, and the ore is all partially peroxidized. It is red in color, and usually mottled. In the census year 11,200 tons of ore were mined. A sample from about 50 tons of the ore on the cars contained—

	No. 372.
	Per cent.
Metallic iron	57.11
Phosphorus	1.618
Phosphorus in 100 parts iron	2.833

d

The *Orchard* mine (59), north of the railroad track at Port Oram, was reopened in February, 1879. It is owned by the estate of James C. Lord and is worked by the executors of the estate. During the census year 14,000 tons of ore were shipped. The total yield of the mine is estimated at 168,000 tons. The mine is between 500 and 600 feet deep. A sample of the ore from the cars contained—

	No. 373.
	Per cent.
Metallic iron	55.00
Phosphorus	1.722
Phosphorus in 100 parts iron	3.130

e

The *Huff* mine (60), in Rockaway township, and also near Port Oram, was reopened in October, 1879, by the Chester Iron Company. Work was discontinued after a few months, and the mine was idle when visited. In the census year 5,015 tons of ore were mined. The total production of the mine is estimated at over 78,000 tons.

The *Washington Forge* mine (61), east of the Huff, was likewise reopened in October, 1879. It is being operated by R. P. Brown & Co. under lease from the Carbon Iron Manufacturing Company. The mine produced before the end of the census year 2,721 tons of ore. The average depth of the workings is 175 feet. One shaft is, however, down to a depth of 300 feet. The mine is wet, and the ore resembles that from the Hurd mine in general appearance. A sample from a pile of 50 tons of the ore contained—

f

	No. 374.
	Per cent.
Metallic iron	57.39
Phosphorus	1.261
Phosphorus in 100 parts iron	2.197

The *Mount Pleasant* mine (62) is northeast from the Washington Forge. It is owned by the estate of James C. Lord, and is operated by the executors. In the census year 22,525 tons of ore were raised. The total yield of

the mine is estimated at 336,000 tons. When visited no ore was being mined in the southwestern workings (see *Geology of New Jersey*, 1868, page 579). The northeastern pit is now 550 or 600 feet deep. A sample from 10 car-loads, about 110 tons, of the ore contained— a

	No. 375.
	Per cent.
Metallic iron	64.86
Phosphorus	0.185
Phosphorus in 100 parts iron	0.285

The *Richards'* mine (63) is owned and worked by the Thomas Iron Company. It produced in the census year 35,463 tons of ore. The ore is all used at Hokendauqua, Pennsylvania. The ore is raised through three shafts. Beginning at the southwest, shaft No. 7 is not far from the old Baker mine, abandoned in 1877; it is 160 feet deep. Shaft No. 6 is the next in line, and is 375 feet deep. Shaft No. 3 is about 500 feet beyond No. 6, and is 400 feet deep, but as it starts from higher ground its bottom is about on a level with No. 6. These two shafts are connected by a drift for drainage purposes. The pump is located in shaft No. 6. The vein between the shafts is reported to be from 6 to 10 feet wide. Samples of ore from each shaft, collected on the cars, contained— b

	No. 376.	No. 377.	No. 378.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	61.43	58.05	62.32
Phosphorus	0.881	0.851	0.661
Phosphorus in 100 parts iron	1.434	1.465	1.061

c

Sample No. 376 is from 4 car-loads of ore from shaft No. 7; sample No. 377 from 5 car-loads of ore from shaft No. 6, and sample No. 378 from 5 car-loads of ore from shaft No. 3. Like nearly all the ores of the Mount Hope range it is, as a rule, coarsely granular (but rarely "shotty"), and contains apatite.

The *Allen* mine (64), which adjoins the Richards on the northeast, is owned by the New Jersey Iron Mining Company, and is worked by the Andover Iron Company. The ore is used at Phillipsburg. In the census year 10,130 tons of ore were mined. The mine is entered by a tunnel driven northward into the hill to cut the vein. The stope is northeast of the tunnel and about 250 feet below the tunnel level. When visited in early June, 1880, very little ore was being mined, as the vein had pinched to 18 inches in width. A sample from 3 car-loads of ore contained— d

	No. 379.
	Per cent.
Metallic iron	56.99
Phosphorus	0.593
Phosphorus in 100 parts iron	1.041

The *Teabo* mine (65), northeast of the Allen, is owned and worked by the Glendon Iron Company. The ore is used in Glendon, Pennsylvania. The mine produced in the census year 22,468 tons of ore. The total yield of the mine is not known; but from January 1, 1871, to January 1, 1879, 144,766 tons were raised. Ore is now raised through two shafts, Nos. 2 and 3, 460 and 355 feet deep, respectively. These shafts are connected underground. The vein averages 10 feet in width between the two shafts. Shaft No. 1 is southwest of No. 2, and is not in use. A sample from 12 car-loads of the ore contained— e

	No. 380.
	Per cent.
Metallic iron	59.31
Phosphorus	0.468
Phosphorus in 100 parts iron	0.789

f

A portion of the ore is very finely granular to compact in texture, has a jointed structure, and a purplish tinge of color. Other specimens of the ore are coarsely-granular magnetite with quartz and mica.

The *Mount Hope* mines (66). Of the five or six distinct veins of ore on mount Hope and Hickory hill, the "Small" and the "Side Hill" are not worked, the Brannin is worked on Hickory hill only, while the Elizabeth or Cross vein and the Taylor or Jugular vein are both worked largely, and the Teabo vein is worked to a small extent through the Elizabeth mine. The Jugular vein was, however, reopened in January, 1880, and the Elizabeth alone has been steadily worked during the past five years. The production of the several openings in the census year was 50,379 tons of ore. The mines are owned and operated by the Mount Hope Mining Company. The ore is sold to New Jersey and Pennsylvania furnaces. Some years ago a tunnel was driven in from the bottom of the hill to

a cut the Jugular vein, and the ore has since been run out through this opening. The workings are now some 200 feet below the tunnel level. The vein exhibits the pinch and shoot structure to a marked degree, the ore varying in width along a level from 18 inches to 25 feet. A sample from 8 car-loads of the ore contained—

	No. 381.
	Per cent.
Metallic iron	58.77
Phosphorus	1.177
Phosphorus in 100 parts iron	2.003

b The Elizabeth vein is worked by a slope from the south side of the hill. The track is laid along a pinch which pitches toward the northeast at an angle of 25° to 35°. The slope is about 700 feet long. At the present stope the ore is 20 to 25 feet wide. A sample from 14 car-loads of the ore contained—

	No. 383.
	Per cent.
Metallic iron	57.67
Phosphorus	0.971
Phosphorus in 100 parts iron	1.683

c The Teabo vein is cut into from the Elizabeth mine about 60 feet below the surface. The ore is finely granular, and has a purplish tinge of color, resembling some of the ore from the Teabo mine. The ore differs very much from the Elizabeth ore, which is as a rule coarsely granular, and has a blue-black color. A sample of the Teabo ore taken across the stope, where the vein is about 10 feet wide, contained—

	No. 382.
	Per cent.
Metallic iron	60.61
Phosphorus	0.577
Phosphorus in 100 parts iron	0.952

d The ore from the Brannin vein, on Hickory hill, is very much weathered. The present opening is about 60 feet deep, and the vein is about 6 feet in width. A sample from 2 car-loads of ore contained—

	No. 384.
	Per cent.
Metallic iron	60.81
Phosphorus	1.230
Phosphorus in 100 parts iron	2.023

e About 3 miles northwest from Mount Hope, near *Denmark Pond*, a small mine (67), on land belonging to E. C. Fiedler, was reopened in January, 1880; 475 tons of ore were shipped from the mine in the census year, but 200 tons of this were mined two or three years ago. The ore contains much pyrrhotite, and resembles the Green Pond ore (sample No. 393). A sample of it, from a few tons of ore at the mine, contained—

	No. 385.
	Per cent.
Metallic iron	49.76
Phosphorus	0.056
Phosphorus in 100 parts iron	0.113

f The *Beach Glen* mine (68) is located near Hibernia, about 3 miles northeast of Mount Hope. It is owned by the estate of James C. Lord, and is operated by the executors. During the census year 9,486 tons of ore were shipped. A sample of the ore from the cars contained—

	No. 386.
	Per cent.
Metallic iron	48.63
Phosphorus	0.025
Chromium	Present.
Phosphorus in 100 parts iron	0.051

The *Hibernia* mines are all located on the same bed or vein of ore, which is remarkable among New Jersey a iron-ore deposits for its great size and regularity. It has been worked almost continuously for a length of 5,000 feet, and the total yield is estimated at over 2,000,000 tons. During the census year nearly 140,000 tons of ore were produced, and the mines were worked to their full capacity but for part of the time. A map of the mines is given in the *Geology of New Jersey*, 1868, facing page 564, and, excepting that the workings have been deepened, the conditions are about the same now as they were when the map was made. Beginning at the southwest, the *Lower Wood* mine (69), owned by the New Jersey Iron Mining Company, is worked by the Andover Iron Company. The average depth of the mine is about 260 feet, while the deepest portion is some 380 feet below surface. In the southwestern stope there is but one vein of ore, but in the northeastern stope there are two veins, each 2 to 3 feet in width, and separated by about 2 to 4 feet of rock. The northwest vein is continuous from the Lower Wood to the Willis, but the southeast one extends only through the Scott tract, or, possibly, to the De Camp. b

The *Glendon*, *Scott*, and *De Camp* (or *Upper Wood*) mines (70) are all worked by the Glendon Iron Company. A track has been laid, partly on stulls and partly on pillars, along the vein from the hill-side to the De Camp mine; the track has been stulled over, and through the tunnel thus formed the ore is all run out on cars drawn by a small Baldwin locomotive. The ore is raised to the tunnel-level in skips or buckets by hoisting-engines on the top of the hill.

In the northeast stope in the Scott mine, about 80 feet below the tunnel-level, the northeast vein is $3\frac{8}{10}$ feet wide, the southeast vein is 9 feet wide, and the veins are separated by 5 feet of rock. This intervening rock is blasted down and raised to the surface. Samples were taken across each of the above-described veins and contained— c

	No. 387.	No. 388.
	Per cent.	*Per cent.*
Metallic iron	58.22	57.27
Phosphorus	0.407	0.139
Phosphorus in 100 parts iron	0.699	0.243

Sample No. 387 is from the northwest vein; sample No. 388 is from the southeast vein.

Average samples of the ore from the mines worked by the Glendon Iron Company and the mine (Lower Wood) worked by the Andover Iron Company were collected from the cars. The samples contained— d

	No. 389.	No. 390.
	Per cent.	*Per cent.*
Metallic iron	53.75	56.00
Phosphorus	0.364	0.223
Phosphorus in 100 parts iron	0.677	0.398

Sample No. 389 is from 24 car-loads of ore from the Glendon mines; sample No. 390 is from 14 car-loads of ore from the Lower Wood mine.

From January 1, 1867, to December 31, 1879, 412,695 tons of ore were raised from the Lower Wood mine; from January 1, 1871, to December 31, 1879, 311,754 tons were produced from the Glendon mines. During the census e year the product was 41,576 tons and 85,622 tons, respectively.

The ore is shipped over the Hibernia railroad to Rockaway, and thence by rail or Morris canal principally to Phillipsburg, New Jersey, and Glendon, Pennsylvania.

The *Willis* mine (71) is at the northeast end of the Hibernia vein. It is owned by the New Jersey Iron Mining Company, and is worked by the Bethlehem Iron Company. The mine was reopened in November, 1879, after having been idle for about 18 months. In the census year 10,975 tons of ore were raised. The production of the mine from January 1, 1868, to May 31, 1880, was 142,160 tons. The ore is teamed to the foot of the hill, and thence is shipped by rail and canal. A sample taken from a canal-boat load at Rockaway contained— f

	No. 391.
	Per cent.
Metallic iron	49.82
Phosphorus	0.343
Phosphorus in 100 parts iron	0.689

Southwest of the Lower Wood mine, and on the other side of Hibernia brook, the *Beach* or Montauk mine was reopened in March, 1880, by the Andover Iron Company. Before the end of May 357 tons of ore were mined. The mine is believed to be on the extension of the Hibernia vein. The ore was not sampled.

a About 2½ miles northeast of the Willis mine, and east of Splitrock pond, the *Cobb* mine (72) was worked during the census year by the Splitrock Forge and Mining Company for the supply of the Wilson forge, at Splitrock; 1,288 tons of ore were produced. The vein of ore has been opened for a length of several hundred feet and to a depth of about 120 feet. At the stope the vein is 5 feet wide, but nearly one-half of the material from the mine goes to the rock-dump. The ore is calcined in an ordinary lime-kiln and then crushed between rolls before it is ready for the forge. A sample from 25 tons of the calcined and crushed ore contained—

b

	No. 392.
	Per cent.
Metallic iron	59.79
Phosphorus	0.426
Phosphorus in 100 parts iron	0.712

The *Splitrock Pond* mine, at the northeast end of the pond, was reopened in the spring of 1880 by William S. De Camp, and 560 tons of ore were mined. Work had been discontinued before the mine was visited, and the ore was not sampled.

The *Green Pond* mine (73) is on the east side of Copperas mountain. It was worked in the census year by the creditors of the Green Pond Iron Mining Company, Charles E. Maxwell, trustee; 18,053 tons of ore were raised and shipped to different furnaces in New Jersey and Pennsylvania via the Green Pond Mine railroad to Charlotteburg, c and thence by the New Jersey Midland and other railroads. The mine is comparatively a new one, having made its first shipment of ore about the year 1873. The ore lies in several distinct shoots, which pitch at about 30° and dip at about 40°. Two shoots have been worked to a depth (or length) of 320 feet, a third to 125 feet, and a fourth to 85 feet. The ore from all the openings is very much alike. It contains hornblende and pyrrhotite (the latter in such quantities as to necessitate the ore being roasted before being used in the blast-furnace), and often green mica. A sample was collected from 2 car loads of ore from each of the four pits (8 car-loads in all); it contained—

d

	No. 393.
	Per cent.
Metallic iron	51.33
Phosphorus	0.033
Phosphorus in 100 parts iron	0.064

The *Charlotteburgh* mine (74), near Charlotteburgh, was reopened in February, 1880, by Cooper, Hewitt & Co. From this and the Davenport opening near to it 3,920 tons of ore were mined in the census year. The Charlotteburgh mine is 60 feet deep. A sample of the ore from a pile of about 30 tons contained—

e

	No. 394.
	Per cent.
Metallic iron	58.15
Phosphorus	0.151
Phosphorus in 100 parts iron	0.260

The *Rockaway Valley* or *De Camp* mine, and the *Pike's Peak* or *Stony Brook* mine, were both reopened in the fall of 1879. About 500 tons of ore were raised from the former and 100 tons from the latter. The mines were, however, idle when visited in June, 1880, and the ore was not sampled.

The *Ringwood* mines (75), situated in the northern part of Pompton township, Passaic county, are owned and worked by Cooper, Hewitt & Co. In the census year 26,482 tons of ore were mined. From May 31, 1874, to May 31, 1880, 103,398 tons were produced. The total yield is estimated at 896,000 tons. Many of the openings were f worked in the last century. Of the many mines on the tract four only were worked in the spring of 1880. These were the Cannon, the Peter, the Hope, and the Hewitt (see Fig. 56). By far the largest amount of ore raised came from the Cannon and Peter mines.

The *Cannon* mine is near the southern side of the tract. The large opening described in the *Geology of New Jersey* has been abandoned, and a new opening has been made east of the old pit upon another shoot of ore. The new pit is 60 feet wide.

The *Peter* mine is about a mile northeast of Cannon. It was worked in pre-revolutionary times, and some of the old timbers still remain and are in good condition. The structure of the ore-body is complicated; two or three shoots of ore, all pitching toward the northeast, appear to unite not far below surface, there forming a large pocket. The mine is dry, and the ore is easily exploited.

The *Hope* mine, comprising a number of openings along the side of Hope mountain, is on the extension of the Peter range. An old pit about half-way up the hillside was worked a little while in the spring of 1880; but nearly all the operations (they have not been extensive) have been on several small shoots of ore at the foot of the hill, near the tramway.

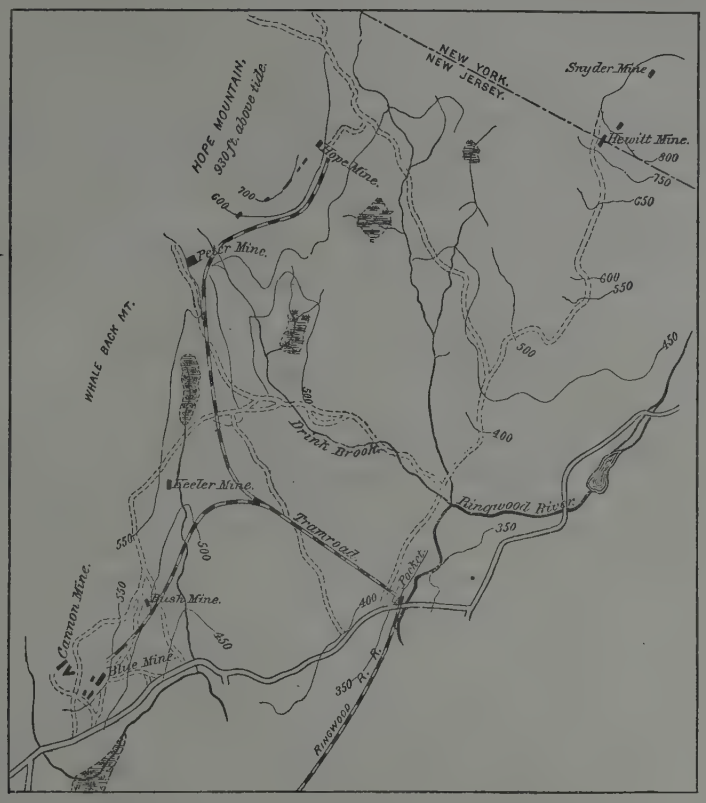


FIG. 56.

The *Hewitt* mine is near the state line. The vein stands almost vertically, and has been worked in open cut to a depth of about 25 feet. The ore is 6 to 8 feet wide; it is reddish in color, owing to partial peroxidation.

Samples of the ore from each of the above-mentioned mines contained—

	No. 395.	No. 396.	No. 397.	No. 398.	No. 399.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	55.25	55.56	62.66	63.20	52.32
Phosphorus	1.567	1.556	0.458	0.448	0.078
Sulphur					3.324
Phosphorus in 100 parts iron	2.818	2.801	0.731	0.709	0.149

Sample No. 395 is from the Cannon mine; the sample was collected from the cars. Sample No. 396 is from the Peter mine; it was also collected from the cars. Both ores vary in texture, but on the whole resemble each other in mass. The Cannon ore has, however, a purple color when powdered, which distinguishes it.

Samples Nos. 397 and 398 are from the Hope mine. Sample No. 398 is from the opening on the hillside. The ore is "shotty", while that from the newer openings, at the bottom of the hill, is finely granular (sample No. 397). The samples were taken from piles of ore at the mine.

Sample No. 399 represents the Hewitt ore. It was taken from the cars.

RAMAPO BELT.

The *Butler* mine (76), near Sufferns, Hohokus township, Bergen county, was worked for one month in the census year and produced 280 tons of ore.

The *Brown* mine (77), near Midvale, Pompton township, Passaic county, was reopened in February, 1880. Before the close of the census year 1,232 tons of ore were mined.

a The *Kahart* mine, in Pequannock township, Morris county, was in operation for three or four weeks and 50 tons of ore were raised.

The *De Bow* mine (78), near Pompton Plains, Pequannock township, Morris county, was worked for two months and 112 tons of ore were mined.

The *Beer's* mine, near Morris Plains, Hanover township, Morris county, was in operation one month and a half and produced 22 tons of ore.

No samples of ore were taken from this belt.

LIMONITE.

In the *Annual Report of the State Geologist of New Jersey for* 1880 twenty-two localities are given where limonite
b has been found. At fifteen of these some work was done in the census year, and ore was raised from eleven mines. The total production of limonite in the state during the census year was 15,503 tons, and of this amount 12,354 tons were raised from three pits near Beattyestown, Warren county.

The ore occurs associated with the magnesian limestone in the valleys lying between the gneiss ridges of the Highlands. Beginning at the southwestern portion of the belt, there are three openings on the same body of ore near Carpentersville, Greenwich township, Warren county, southeast of Pohatcong creek. The pits are known as the Rapp, Carpenter, and Riegel mines. In the census year 392 tons of ore were mined at the Rapp opening. The others were not worked. In Lopatcong township a mine on William Hamlen's farm produced 344 tons of ore, and one near New Village 374 tons. On Marble mountain, Lopatcong township, some work was done in the summer of 1880 in searching for limonite, but no ore was raised before June.

c In Hunterdon county 565 tons of "hematite and ocher" were raised from the Wean mine. Most of this was sold for paint. From the Radley mine, Lebanon township, 78 tons of ore were shipped. In German valley, both in Lebanon township, Hunterdon county, and in Washington township, Morris county, ore has been mined. The Neighbour mine, on Sylvester Neighbour's farm, in Washington township, 2 miles northeast of Califon, produced 836 tons of ore in the census year, which was used in the Chester furnace. The ore contained, however, according to an analysis made in the state survey laboratory, (*a*) 3.74 per cent. metallic lead and 10 per cent. metallic zinc, which proved troublesome in the furnace, and the use of the ore was discontinued and the mine was abandoned. The Dafford mine, near the Neighbour, produced about 500 tons of ore in the census year. It, too, was worked but part of the year.

Near Beattyestown, about 3½ miles south of Hackettstown, in Mansfield township, Warren county, are the
d *Thomas*, *Shields'* and *Brown* mines (79). They are all on land belonging to Thomas Shields.

The Shields mine is the largest of the three, and lies between the other two. It is worked by A. Pardee & Co. The ore is used at Stanhope. In the census year 9,870 tons of ore were mined. From 1872 to June, 1880, 41,121 tons of ore were produced. The pit is about 60 feet deep and about 400 feet long by 80 feet wide. The stripping has varied from 6 to 30 feet. The east wall of the pit is blue limestone (magnesian), and the slate outcrops not far from the pit on the southwest. The ore is mixed with yellow clay. About three-quarters of the material raised from the mine is lost in washing. Very little lump-ore is found in the mine.

A sample of the ore collected at Stanhope furnace from a pile of about 25 tons yielded, on complete analysis—

e

	No. 325.		No. 325.
	Per cent.		*Per cent.*
Sulphur	0.041	Phosphoric acid	0.588
Phosphorus	0.257	Carbon in carbonaceous matter	0.11
Iron, metallic	42.73	Hygroscopic water	0.52
Phosphorus in 100 parts iron	0.601	Water of composition	8.88
		Total	99.095
Silica	19.24		
Iron, peroxide	60.99		
Alumina	4.72	Per cent. of insoluble silicious matter	24.91
Manganese, protoxide	1.81		
Lime	0.34	Silica	19.24
Magnesia	0.70	Alumina (with trace of oxide of iron)	4.06
Iron, disulphide	0.077	Lime	0.07
Nickel, oxide	0.06	Magnesia	0.48
Cobalt, oxide	0.04	Potassa	1.02
Potassa	1.46	Soda	0.03
Soda	0.10		
Carbonic acid	0.06	Total	24.90

f

The *Thomas* mine is north of the Shields. It is worked by Joseph Wharton, and the ore is used in the Hackettstown furnace. In the census year 2,050 tons were produced. The *Brown* mine, which adjoins the Shields on the south, is also worked by Joseph Wharton for the supply of the Hackettstown furnace. It was reopened in April, 1880, and 434 tons of ore were mined before May 31.

a Annual Report State Geologist for 1880, p. 120.

In Hope township, Warren county, 3 miles south of Blairstown, the *Swayze* mine was worked in the summer of 1880, but no ore was mined there in the census year.

Limonite has been mined at several localities along the east slope of Pochuck mountain, in Vernon township, Sussex county. The old *Pochuck* mine (80) is west of McAfee's valley, half-way up the mountain side. In 1873 a gravity road was built to the railroad in the valley, and preparations were apparently made for mining on a large scale. Work was stopped, however, in 1876, and since that date the mine has been idle. The pit was filled with water when visited, and no ore was seen in place. No limestone is present near the pit. In the *Annual Report for* 1879, p. 93, the state geologist says: "The mine has been an interesting geological locality, as the ore occurred in small lumps and masses in earths, and the ore-mass was bounded on the northwest and southeast sides by rotten gneissic rocks. These soft strata continue for over 100 feet in depth and 500 to 600 feet in length." The ore contains *graphite*, which is quite common in the magnetic ores of this region. From this, and the fact of the ore occurring in partially-decomposed gneiss, it seems probable that the limonite is merely the outcrop of a vein of magnetite.

A sample of the ore was collected from 75 tons at the Franklin furnace; it contained—

	No. 309.
	Per cent.
Metallic iron	38.60
Phosphorus	0.562
Sulphur	0.132
Phosphorus in 100 parts iron	1.456

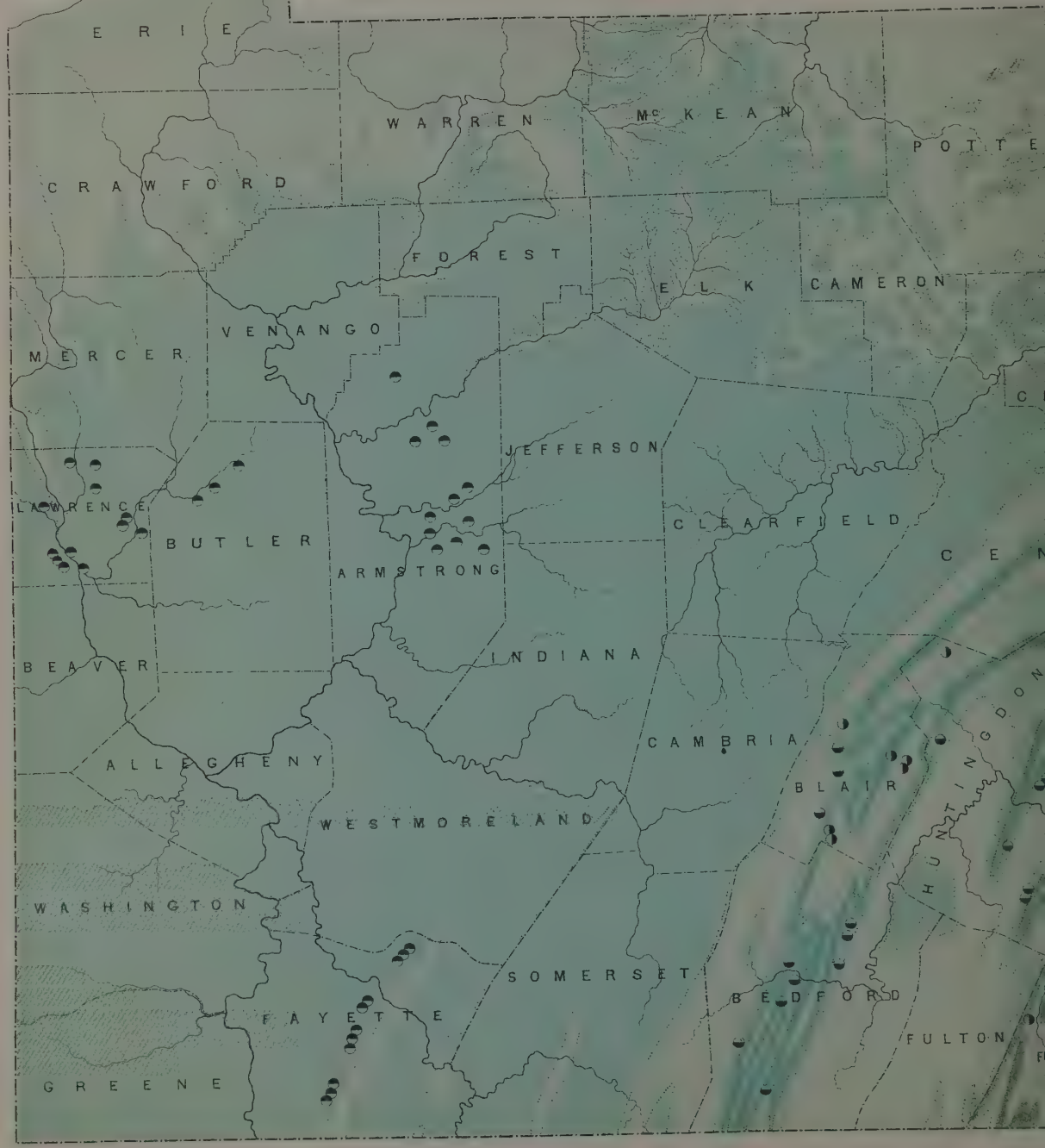
IRON ORE SAMP

GEOLOGY FROM COUNTY MAPS OF THE SEC

In coloring the geology upon this map, no attempt has b
simply to indicate in a general way the geological as

Scale

0 10



Mesozoic. Conglomerate and Coal Measures. Devonian. Upper Silurian.

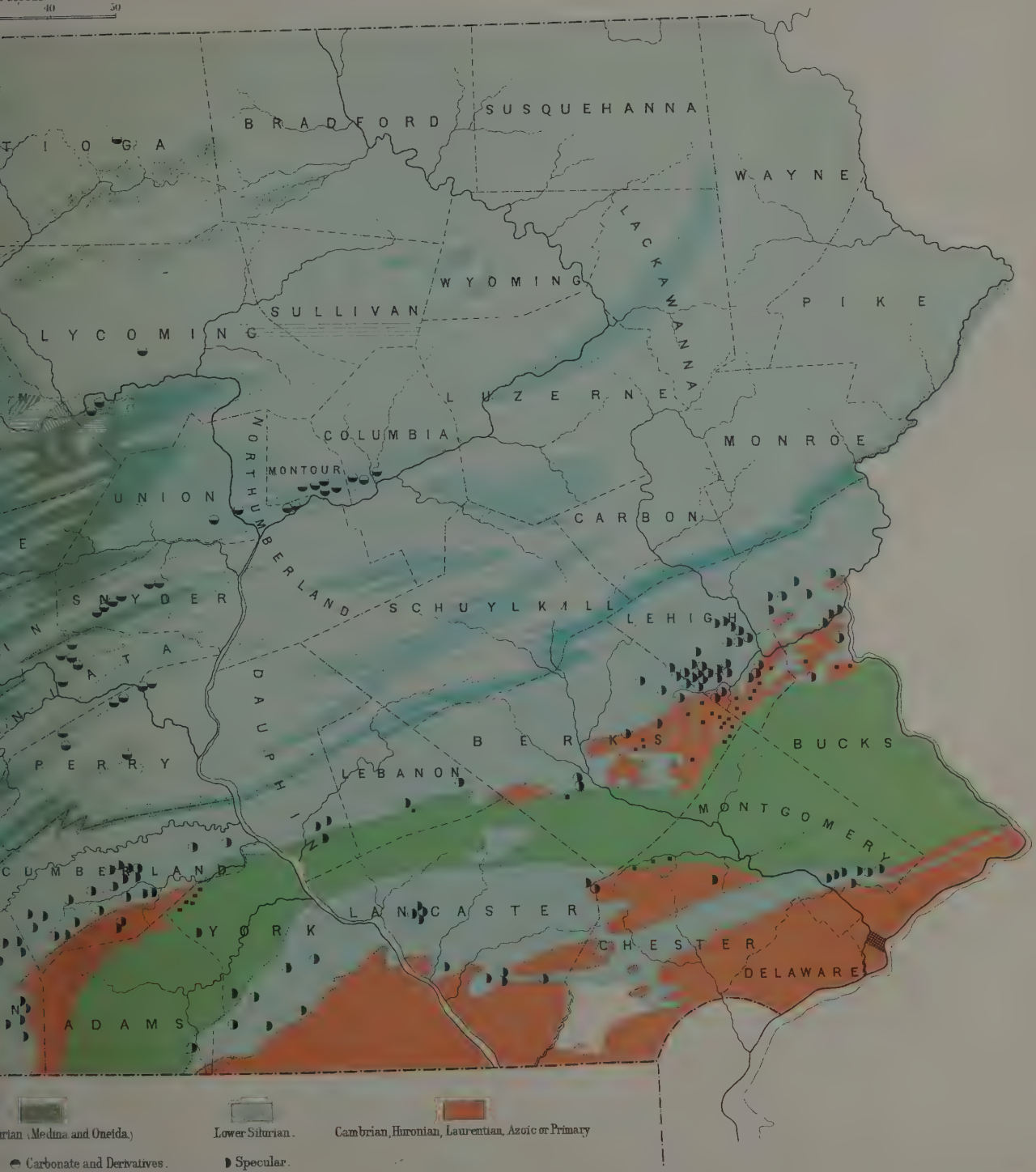
■ Magnetite. ◑ Limonite. ◒ Fossil.

Note: *The ore symbols indicate in a general way the position and relative approximation of the iron m*

P OF PENNSYLVANIA.

OLOGICAL SURVEY, J. P. LESLEY, STATE GEOLOGIST.

llow the boundaries in all their sinuosities. The map is designed.
ographical position of the iron mines worked in the census year.
inch.
40 50



rian (Medina and Oneida.) Lower Silurian. Cambrian, Huronian, Laurentian, Azoic or Primary

Carbonate and Derivatives. Specular.

nsus year. In most cases a single symbol stands for a group of mines.

Julius Bien & Co

NOTES ON THE IRON ORES OF PENNSYLVANIA.

COMPILED FROM THE REPORTS AND UNPUBLISHED MATERIAL OF THE SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA, J. P. LESLEY, STATE GEOLOGIST, AND THE CENSUS SCHEDULES, BY BAYARD T. PUTNAM.

The deposits of magnetic ore associated with the Mesozoic sandstones in Lebanon, York, Berks, and Chester counties were visited and sampled by Mr. Bailey Willis, and Mr. Bayard T. Putnam collected a series of representative samples of the iron ores mined in other parts of the state. Mr. Putnam's samples were not analyzed because the appropriation allotted to this portion of the census work was exhausted before these samples were reached in the laboratory. As Dr. McCreath has made, for the second geological survey of the state, a very great number of analyses of the Pennsylvania iron ores, it was thought best to give preference to the iron ores from the other states, c and the analysis of the Pennsylvania samples was therefore left until the last, and was finally omitted. In order to present in this volume as complete an exhibit as possible of the iron-ore product of the United States in the census year, permission was freely granted by Professor Lesley, state geologist of Pennsylvania, to reprint the analyses published in the reports of the survey, and Dr. McCreath has kindly added to these, by permission of the state geologist, a number of analyses made for the survey which have not yet been published.

Iron ore is widely distributed throughout the state of Pennsylvania. In the census year it was mined in 35 counties, and the state ranked first on the list as a producer of iron ore. The geological range of the iron ores is greater in Pennsylvania than in any other state of the Union.

The accompanying map (Plate XXIX) was compiled to show the geological as well as geographical position of the deposits of iron ore worked in the state in the census year. d

Following the plan of Mr. McCreath's report (MM. of the Pennsylvania survey), the analyses in the following pages are arranged under the *kind* of ore, and are further grouped under each kind in accordance with the geological age of the ore.

I. MAGNETITE.

The magnetic ores of Pennsylvania may be conveniently grouped according to their associated wall-rock, as follows: (1) Magnetic ores in the Archæan gneisses and slates. (2) Magnetic ores associated with the trap-dikes in the Mesozoic sandstone.

For a description of deposits of the second class, see the report of Mr. Bailey Willis. e

The magnetic ores of the first class occur throughout the Archæan slates and gneissoid rocks in the southeastern part of the state. But the workable deposits appear to be almost entirely confined to that portion of the South Mountain belt which lies in the northeastern corner of Bucks county, the southern part of Lehigh county, and the west central part of Berks county. This belt is the southwestern extension of that which in New Jersey and New York forms the highlands, and the general character of the associated ore, and its relation to the inclosing rock in Pennsylvania, is much the same as it is farther north. The Pennsylvania magnetites of both classes differ, however, from the run of the magnetites in New Jersey and southern New York in containing, as a rule, but little phosphorus. Over 80 per cent. of the total magnetic ore product of Pennsylvania was reported to be adapted to the manufacture of Bessemer pig, and it was largely used for that purpose. It is probable that but little of this class of ore will average over 50 per cent. metallic iron, and a large amount of it will run under 45 per cent.

Berks county.—Product of magnetic ore from the Archæan belt in census year, 57,547 tons. The following f analyses are from Report D[3], Vol. II:

	No. 994.		No. 994.
	Per cent.		*Per cent.*
Metallic iron	42.700	Alumina	3.411
Metallic manganese	7.997	Lime	0.040
Sulphur	0.020	Magnesia	1.502
Phosphorus	0.135	Insoluble residue	14.305

994. *Clymer Iron Company's* mine, on Cornman's farm, 2½ miles northeast of Pricetown. Ore for the most part in powder; soft, dull black to brownish black. Shows numerous small scales of mica. Iron for the most part as magnetic oxide.

a

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	35.050	35.500	28.100	30.250	28.950	24.650	41.900	38.400	22.100	59.100
Manganese	.....	.....	.....	.....	.....	1.534	2.478	.....	0.720	7.507
Alumina	.....	.....	.....	.....	8.070	1.501	3.787	.....	6.748	.....
Lime	.....	.....	.....	.....	13.770	25.410	3.880	.....	22.400	.....
Magnesia	.....	.....	.....	.....	8.749	4.396	1.048	.....	9.830	.....
Sulphur	0.023	0.003	0.025	0.175	0.002	0.312	0.175	0.006	0.028	None.
Phosphorus	0.025	0.042	0.059	0.020	0.006	0.024	0.055	0.037	0.018	0.068
Silicious matter	42.340	43.785	48.710	51.190	26.020	10.100	18.610	40.060	30.590	0.860
Phosphorus in 100 parts iron	0.070	0.118	0.210	0.066	0.020	0.097	0.131	0.096	0.081	0.115

b

1. *Greiss & Weudling's* mine.
2. *Frederick's* mine.
3. *Butz's* mine.
4. *Charles Geary's* mine, Rittenhouse gap.
5. *Tatham Brothers'* mine, near Topton.
6. *Guiterman's* mine; *hard ore*, with carbonates of lime and magnesia.
7. *Guiterman's* mine; *soft ore.*
8. *Haines & Klutz's* mine (George Wetzel), half mile west from Red Lion station, Bethlehem Iron Company.
9. *Fritch & Brother's* mine, near Mertztown.
10. *Clymer Iron Company's* open cut, 2 miles southwest from Pricetown; soft ore.

c

In *Lehigh county*, 70,398 tons of magnetite were mined; in *Bucks county*, 24,192 tons; and in *Northampton county*, 732 tons—all from the gneiss belt. No analyses of these ores are available, but they are similar in character to the corresponding ores in Berks county.

II. HEMATITE.

Deposits of anhydrous sesquioxide of iron are of rare occurrence in Pennsylvania. A so-called "red oxide" is found associated with limonite at some of the banks, notably at Haldeman's bank, in York county, northeast of Hanover. An analysis of this ore shows, however, the presence of nearly 6 per cent. of water (see Professor d Frazer's *Report on York County, C*, p. 62). Grains of both specular and magnetic ore are often found with the limonite elsewhere in York county, both in the Archæan gneisses and primal slates, and "red hematite" occurs in small quantities associated with primal slates in Berks and Lehigh counties.

Micaceous specular ore occurs in the belt of Mesozoic sandstone near Dillsburg, in York county, and in the neighboring counties. Outside of York county, however, this variety of ore was mined in Pennsylvania in the census year at but one locality—near Hummelstown, Dauphin county.

The character of this class of ore is shown in the following analyses, taken from Report MM, p. 222:

e

York county.	No 438.	No. 185.
	Per cent.	*Per cent.*
Protoxide of iron	2.121	.....
Sesquioxide of iron	88.357	82.607
Sesquioxide of manganese	0.016	0.041
Oxide of copper	None.	0.222
Alumina	3.424	4.843
Lime	1.290	0.760
Magnesia	0.479	0.918
Sulphuric acid	0.010	0.150
Phosphoric acid	0.291	Traces.
Carbonic acid	None.	0.123
Water	0.551	1.277
Insoluble residue	3.373	9.530
Total	99.913	100.471
Metallic iron	63.500	57.825
Metallic manganese	0.011	0.029
Sulphur	0.024	0.060
Phosphorus	0.127	Trace.

f

438. *Mine ore-bank*, 2½ miles southwest from Wellsville. McCormick & Co., lessees. See Report CC, page 236. Red hematite, with foliated, micaceous hematite; unctuous; reddish-brown and iron black. Slightly impregnated with magnetite.

185. *Mine ore-bank*, 2½ miles southwest from Wellsville. McCormick & Co., lessees.

a

Adams county.	No. 435.	Percentages.
	Per cent.	
Protoxide of iron	0.321	= 50.900 per cent. iron.
Sesquioxide of iron	72.357	
Sesquioxide of manganese	0.031	= 0.022 per cent. manganese.
Alumina	0.999	
Lime	0.240	
Magnesia	0.133	
Sulphuric acid	0.017	= 0.007 per cent. sulphur.
Phosphoric acid	0.007	= 0.003 per cent. phosphorus.
Water	0.224	
Silicic acid ($Si O_2$)	25.660	
Total	99.989	

b

435. *George Cole's* ore-opening, 1½ miles from Newmans, on the Cole's Valley road. See Report CC, p. 249. Specular iron ore; foliated, brittle; iron black, with gangue of quartz.

In *Perry county* a thin seam of hematite occurs in the Catskill formation (IX), (see Report M³, pp. 37 and 38) and occasional nodules of hematite have been found in the Coal Measures (see Report MM, p. 373). In neither case, however, does the ore occur in quantities of economic importance.

c

III. LIMONITE.

LIMONITE ORES OF THE SILURO-CAMBRIAN FORMATION.

Everywhere throughout Pennsylvania, wherever the great limestone formation No. II occurs, there are found more or less important deposits of brown hematite iron ore. It is this horizon that has supplied the greater part of the stock to the furnaces along the Lehigh, Schuylkill, and Susquehanna rivers, and the whole of the stock to the old furnaces of the Kishicoquilis, Nittany, and Canoe valleys, and Morrison's Cove, in middle Pennsylvania, as well as to the furnaces in Mountain Creek valley, in Cumberland county, and Path valley and the Conecocheague region of Franklin county.

They are scattered over the surface of the southern or limestone half of the Cumberland valley, from the Lehigh river to Maryland, and southward through Virginia and East Tennessee to Alabama (MM, p. 199). But they are distinguishable into ores at the top, ores in the middle, and ores at the bottom of the great limestone formation No. II. Those at the top form a belt along the middle of the valley d where the Magnesian limestone underlies the Trenton limestone, or, in its absence, the Utica or Hudson river slates, formation No. III. This line of ore-deposits is represented by the great mines of Ironton in Lehigh and Moselm in Berks counties; the mines along Spruce creek, in Centre and Blair; the Henrietta, Leathercracker, and Bloomfield mines, in Morrison's Cove, Blair county; and the old Mount Pleasant and Carrick furnace banks, in Path valley, Franklin county.

Those in the middle are connected with various horizons of ferruginous limestones in the Chazy and Calciferous. Those at the bottom, along the north or west foot of the South Mountain-Blue Ridge range, are geologically connected with the Potsdam sandstone, or the slates which intervene between it and the base of the Calciferous, and are *locally* known as "mountain ores". This lower line of ore-deposits is represented by the great mines of Springfield, in Canoe valley, Blair county; at Pine Grove, Boiling Springs, and at the No. 1 Clever mammoth bank, in Cumberland county; at Pond bank and Mont Alto, in Franklin county; and a long line through the Shenandoah valley, in Virginia.

In the Cumberland valley, in York, Cumberland, and Franklin counties, these ores have been very extensively mined both for local use in the furnaces of the valley and for shipment to Harrisburg, Reading, Columbia, etc., to be smelted along with the more refractory e magnetites. The best developments have been made along the line of the South Mountain railroad; at Boiling Springs, at Cleversburg, and near Shippensburg, in Cumberland county; along the line of the Mont Alto railroad; and in Path valley, in Franklin county; and on Dogwood run, in York county. (*a*)

Northampton county.—Production of limonite in census year, 121,794 tons. The character of some of this ore is shown by the following analyses, taken from Report MM, p. 218:

	No. 980.	No. 967.		No. 980.	No. 967.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sesquioxide of iron	49.928	63.714	Water	11.384	11.980
Sesquioxide of manganese	7.358	0.455	Insoluble residue	26.700	21.940
Sesquioxide of cobalt	0.140	0.040	Total	100.302	100.586
Alumina	3.053	1.090			
Lime	0.110	0.180	Metallic iron	34.950	44.600
Magnesia	0.418	0.324	Metallic manganese	5.123	0.317
Sulphuric acid	0.042	0.027	Sulphur	0.017	0.011
Phosphoric acid	1.169	0.836	Phosphorus	0.509	0.365

f

980. *Wharton* mine of Saucon Iron Company, 2 miles east from Hellertown. Specimens from higher level, about 80 feet deep. Lump- and wash-ore. Compact, brittle, sandy; dark-brown to reddish-brown.

967. *Wharton* mine of Saucon Iron Company, 2 miles east from Hellertown. From deep shaft, 126 feet under ground. Lump- and wash-ore. Hard, tough, fine-grained; color, liver-brown.

a Report M³, p. ix, *et seq.*

a *Lehigh county.*—Production of limonite in census year, 349,302 tons. The following analyses and notes of the limonite of Lehigh county are from Report M, pp. 48 to 54, and Report MM, pp. 213 to 218:

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	37.000	32.700	46.600	45.300	46.500	33.300	47.000	47.900	44.600	44.500	51.250	43.000	51.950
Manganese	3.038	0.374	0.454	0.749	0.590	0.612	0.518	0.266	0.576	9.280	0.381	4.575	0.360
Sulphur	0.035	0.030	0.027	0.032	0.022	0.007	0.030	0.003	Trace.	0.019	0.016	0.049	Trace.
Phosphorus	0.186	0.179	0.597	0.137	0.128	0.170	0.111	0.165	0.151	0.316	0.100	0.109	0.106
Insoluble residue	28.990	39.050	16.230	21.060	16.300	34.250	16.050	11.890	20.340	6.280	11.010	19.060	11.430

b

	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	48.500	48.000	38.000	48.250	42.300	48.200	48.100	57.500	58.500	45.700	48.500	51.750	49.300
Manganese	0.194	0.173	1.484	0.432	0.648	0.418	0.360	0.749	0.223	0.648	0.360	0.309	0.216
Sulphur	Trace.	0.032	0.020	0.045	0.026	0.005	0.045	Trace.	0.084	0.034	0.002	Trace.	Trace.
Phosphorus	0.123	0.120	0.108	0.025	0.100	0.158	0.164	0.165	0.043	0.157	0.328	0.270	0.235
Insoluble residue	16.560	15.950	30.970	18.450	24.120	14.810	13.440	3.470	2.800	20.210	15.580	10.350	15.120

c

	XXVII.	XXVIII.	XXIX.	XXX.	XXXI.	XXXII.	XXXIII.	XXXIV.	XXXV.	XXXVI.	XXXVII.	XXXVIII.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	46.600	49.000	51.700	45.000	28.100	51.400	47.000	36.500	49.600	43.700	42.800	50.400
Manganese	0.144	0.187	Trace.	0.626	5.029	0.295	7.464	2.932	0.583	0.763	0.252	1.203
Sulphur	Trace.	Trace.	0.214	Trace.	0.002	0.021	0.003	0.031	0.007	0.005	0.036	0.002
Phosphorus	0.276	0.172	0.066	0.190	0.551	0.233	0.630	3.135	1.288	0.869	0.222	0.993
Insoluble residue	19.880	15.400	10.550	21.900	36.430	11.290	4.940	18.900	9.440	18.580	25.040	10.050

I. *Harry Kaiser's* mine, leased by Mull & Hagenbuch, north of Lock ridge, 1 mile west of Alburtis. (R. P., 1874, D, p. 18.) Sample partly lump and partly fine ore. Limonite, hard and sandy, with considerable quartz in fine ore.

II. *Jonas Kreischmann's* mine, leased by Allentown Rolling-Mill Company, 1 mile east of Alburtis. Vein ore. (R. P., 1874, D, p. 18.) Limonite hard, compact, and very sandy.

d III. *Jonas Kreischmann's* mine, leased by Coleraine Iron Company, 1 mile east of Alburtis. Wash ore. (R. P., 1874, D, p. 19.) Limonite, wash ore, with considerable admixture of ferruginous clay.

IV. *Wiand's* mine, leased by the Temple Iron Company. (R. P., 1874, D, p. 21.) Sandy limonite, with considerable quartz in the fine ore.

V. *P. Marck's* mine, leased by Lehigh Iron Company. (R. P., 1874, D, p. 21.) Limonite, hard, compact, arenaceous, with somewhat slaty structure.

VI. *Maple Grove Mill* property, near Hensingerville. (R. P., 1874, D, p. 21.) Limonite, hard, compact, exceedingly silicious, with slaty structure, and light-brown color.

VII. *J. Barber & Company's* mine, Hensingerville, 1½ mile south-southwest of Alburtis. (R. P., 1874, D, p. 22.) Limonite, compact, with large mass of fibrous ore.

VIII. *Shankweiler* lot, at Hensingerville, 78 feet below the surface. (R. P., 1874, D, p. 23.) Limonite, very hard and compact, slaty structure, surface somewhat velvety.

e IX. *Thomas Iron Company's* mine, at Hensingerville. (*a*) (R. P., 1874, D, p. 24.) Limonite, hard, compact, and of somewhat slaty structure.

X. *Hensinger Heirs'* farm, 1½ mile south of Alburtis. (R. P., 1874, D, p. 24.) Limonite, bomb-shell ore, curiously honeycombed, with lage amount of göthite.

XI. *Ludwig's Old* mine, 1 mile west-northwest of Alburtis. (R. P., 1874, D, p. 26.) Limonite, hard, arenaceous, with broken concretions of pipe ore.

XII. *Blank's* mine, leased by Ludwig, Hertzog & Co., one-fourth mile northwest of Alburtis. (R. P., 1874, D, p. 27.) Limonite, compact, arenaceous, containing cavities lined with göthite and lepidocrocite. Specimen also contained a small piece of arenaceous red hematite, and a small amount of pipe ore.

XIII. *Reuben Romig's* mine, leased by Allentown Iron Company, three-fourths of a mile east of New Texas. (R. P., 1874, D, p. 29.) Limonite, compact, cellular, with considerable admixture of yellow clay.

XIV. *Werner & Reinhart's* mine, leased by the Allentown Iron Company, one-half mile east of New Texas. (R. P., 1874, D, p. 29.) Limonite, compact and cellular, with admixture of ochreous earth.

f XV. *Werner & Reinhart's* mine, mined by the Allentown Iron Company. (R. P., 1874, D, p. 29.) Limonite, hard, arenaceous, and compact.

XVI. *Milton Lauer's* mine, leased by Carbon Iron Company. (R. P., 1874, D, p. 29.) Limonite, hard, compact, and very sandy.

XVII. *Frank S. Lichtenwalner's* mine, three-fourths of a mile east of Alburtis. (R. P., 1874, D, p. 30.) Limonite, compact, with nodular concretions and small seams of ochreous iron ore.

XVIII. *Elwin Bastian's* mine, leased by the Lehigh Iron Company. (R. P., 1874, D, p. 31.) Limonite, hard, compact, sandy, with considerable quartz in fine ore.

XIX. *Francis Guth's* mine, leased by Carbon Iron Company, three-fourths of a mile west-northwest of Wescoeville. (R. P., 1874, D, p. 32.) Limonite, hard, compact, and sandy.

a This analysis is put down under Hensinger & Saul's mine in Professor Prime's report, but specimen was from Thomas Iron Company's mine.

XX. *Francis Breinig's* mine, 1½ mile north-northwest of Breinigsville. (R. P., 1874, D, p. 32.) Limonite, silicious, somewhat slaty **a** structure, spongy form; color, various shades of brown and brick red.

XXI. *Oliver Moser's* mine, leased by Northampton Iron Company, one-third of a mile north of Breinigsville. (R. P., 1874, D, p. 33.) Limonite, compact mass of pipe ore, the pipes in some pieces being somewhat obliterated; somewhat cellular, the cells being partially filled with yellow clay; color, dark-brown generally.

XXII. *Thomas Breinig's* mine, leased by Northampton Iron Company, one-third of a mile north of Breinigsville. (R. P., 1874, D, p. 34.) Limonite, very compact, somewhat cellular and stalactitic, botryoidal; color, various shades of brown.

XXIII. *Nathan Whitely's* mine, 1 mile from Trexlertown, on road to Breinigsville. (R. P., 1874, D, p. 35.) Limonite, hard, arenaceous; structure flaggy; some of the pieces decidedly fibrous.

XXIV. *William B. Fogel's* mine, leased by Carbon Iron Company, one-half mile northwest of Trexlertown. (R. P., 1874, D, p. 36.) Limonite, hard, compact, arenaceous, with somewhat laminated structure, and considerable admixture of yellow clay.

XXV. *Henry Swartz and W. B. Fogel's* mine, leased by the Crane Iron Company, at Trexlertown. (R. P., 1874, D, p. 36.) Limonite, **b** sandy, containing small cavities lined with göthite.

XXVI. *Alwyn Bortz's* mine, one-half mile east of Trexlertown. (R. P., 1874, D, p. 36.) Limonite, compact, argillaceous, with considerable admixture of ochreous earth.

XXVII. *Alywn Bortz and William Koch's* mine, leased by Carbon Iron Company, one-half mile east of Trexlertown. (R. P., 1874, D, p. 37.) Limonite, cellular, somewhat nodular, of a dark-brown color.

XXVIII. *Jonas Grammis'* mine, one-half mile east of Trexlertown. (R. P., 1874, D, p. 37.) Limonite, soft and cellular, some of the cells being filled with yellow clay; partly laminated structure.

XXIX. *Gackenbach's* mine, leased by the Crane Iron Company, 2 miles northeast of Trexlertown. (R. P., 1874, D, p. 38.) Limonite, stalactitic, cellular, sandy; color, various shades of brown and vermillion; contains 10.83 per cent. of water.

XXX. *Francis Fisher's* mine, leased by the Coleraine Iron Company, 1½ miles northwest of Wescoeville. (R. P., 1874, D, p. 38.) Limonite, arenaceous, exceedingly hard and tough, with nodular concretions and velvety surface.

XXXI. *J. & D. Smith's* mine, leased by Millerstown Iron Company, 1 mile south-southwest of Fogelsville. (R. P., 1874, D, p. 39.) **c** Limonite, compact and exceedingly sandy, with considerable adhering yellow clay; color, various shades of light and dark brown.

XXXII. *Charles Miller's* mine, three-fourths of a mile south-southwest of Fogelsville; stripping ore. (R. P., 1874, D, p. 39.) Limonite, arenaceous, with a large admixture of ochreous iron ore.

XXXIII. *J. D. Scholl & Co.'s* mine, leased by Lehigh Valley Iron Company, 1½ mile south-southeast of Fogelsville. (R. P., 1874, D, p. 40.) Limonite, compact, cellular, with numerous seams of ochreous earth.

XXXIV. *Jacob Steininger's* mine, leased by James Lanigan, three-fourths of a mile southwest of Fogelsville. (R. P., 1874, D, p. 40.) Limonite, compact, arenaceous, with considerable admixture of ferruginous clay.

XXXV. *Henry Stein's* mine, leased by Thomas Iron Company, 1 mile west-southwest of Fogelsville. (R. P., 1874, D, p. 41.) Limonite, rather compact, with considerable coating of white clay; some of the pieces of a brick red, and others of a foxy color.

XXXVI. *Jesse Laro's* mine, leased by the Crane Iron Company, 1½ mile southwest of Fogelsville. (R. P., 1874, D, p. 41.) Limonite, compact, arenaceous, of a very dark color.

XXXVII. *Levi Lichtenwalner's* mine, leased by the Crane Iron Company. (R. P., 1874, D, p. 42.) Limonite, hard, sandy, with **d** considerable ochreous iron ore.

XXXVIII. *Kræmlich & Lichtenwalner's* mine, leased by the Crane Iron Company, at Fogelsville. (R. P., 1874, D, p. 42.) Limonite, hard, cellular, the pieces being generally of a slaty structure; color, dark-brown and cinnamon-brown.

	XXXIX.	Percentages.
	Per cent.	
Sesquioxide of iron	68.590	=48.013 per cent. iron.
Alumina	2.010	
Oxide of manganese	Trace.	
Lime	0.270	
Magnesia	1.480	
Phosphoric acid	0.340	=0.149 per cent. phosphorus.
Sulphuric acid	0.060	=0.025 per cent. sulphur.
Water, combined	10.750	
Water, hygroscopic	6.950	
Insoluble residue	9.930	
Total	100.380	

e

XXXIX. *Ludwig's New* mine, 1 mile from Alburtis (R. P., 1874, D, p. 25). Average of 6 cars. Analyzed for Pennsylvania Steel Company in 1874, and published by permission of S. M. Felton, esq., president.

f

	No. 61.	No. 62.	No. 69.	No. 391.	No. 369.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	39.300	47.700	50.000	47.000	26.400
Manganese	0.065	2.968	0.208	0.641	17.648
Sulphur	0.008	0.049	0.080	0.053	0.010
Phosphorus	1.269	0.328	0.086	0.061	0.095
Insoluble residue	28.195	12.595	12.520	15.770	21.860

61. *J. Ritter's* mine, at Ironton; leased by the Crane Iron Company. Limonite forming vein in Utica shale and damourite clay. Compact, flaggy, with more or less adhering clay.

a 62. *J. Ritter's* mine, at Ironton. Lump- and wash-ore from bottom of mine (see Report DD, p. 44). Compact, botryoidal; considerable adhering clay and some quartz in wash-ore.

63. *P. Brown's* mine, at Ironton. Lump-ore. Compact, rather fine-grained; dark brown.

391. *P. Brown's* mine, at Ironton. Lump- and wash-ore. Compact, arenaceous; dark brown. (D. McCreath.)

369. *Ironton Railroad Company's* mine, at Ironton. Lump- and wash-ore. Compact, botryoidal; also stalactitic; general structure somewhat flaggy. Some of the ore carries considerable binoxide of manganese.

b

	No. 301.	Percentages.
	Per cent.	
Binoxide of manganese	77.960	=52.631 per cent. manganese.
Protoxide of manganese	4.320	
Sesquioxide of iron	3.660	=2.562 per cent. iron.
Alumina	0.711	
Oxide of cobalt	0.390	
Oxide of nickel	Trace.	
Oxide of copper	Trace.	
Baryta	0.152	
Lime	0.770	
Magnesia	0.236	
Soda	0.368	
Potash	3.042	
Sulphuric acid	Trace.	
Phosphoric acid	0.149	=0.063 per cent. phosphorus.
Water	3.980	
Silicic acid	4.845	
Total	100.583	

c

301. *Ironton Railroad Company's* mine, at Ironton. Manganese wash-ore. Stalactitic, botryoidal, reniform; partially compact and cellular, with cells more or less filled with iron oxide.

	No. 195.	No. 196.	No. 64.	No. 190.	No. 194.	No. 340.	No. 74.	No. 367.	No. 352.	No. 189.
d	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	41.200	51.300	40.600	40.000	41.000	44.200	43.900	46.000	46.300	32.500
Manganese	0.028	0.064	0.554	0.115	0.036	0.036	0.165	0.050	0.201	0.338
Sulphur	0.191	0.106	0.027	0.140	0.098	0.043	0.038	0.073	0.033	0.038
Phosphorus	0.056	0.192	0.393	0.099	0.240	0.760	0.164	0.210	0.264	0.168
Insoluble residue	25.945	9.145	25.460	26.860	26.735	20.315	21.860	17.870	17.500	42.370

	No. 357.	No. 368.	No. 355.	No. 366.	No. 363.	No. 365.	No. 356.	No. 361.	No. 362.	No. 358.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	49.500	49.200	53.000	46.300	34.000	45.200	39.250	36.500	30.100	47.200
Manganese	0.194	0.317	0.216	0.475	0.115	2.132	5.512	1.325	0.489	2.709
e Sulphur	0.019	0.005	0.024	0.018	0.020	0.026	0.029	0.107	0.062	0.039
Phosphorus	0.102	0.180	0.096	0.160	0.676	0.657	0.149	0.547	0.299	0.075
Insoluble residue	13.410	14.005	7.290	15.290	37.695	12.780	21.880	31.215	43.035	14.980

195. *John Heninger's* mine, near Siegersville, 4½ miles west of Catasauqua. Wash-ore (see DD, p. 39.) Compact, arenaceous; carries considerable adhering clay; color, various shades of brown and vermilion.

196. *Hiram Boyer's* mine, near Siegersville, 4½ miles west of Catasauqua. Wash-ore. Leased by Lehigh Valley Iron Company. Cellular, stalactitic; argillaceous. (D. McCreath.)

64. *Samuel Sieger's* mine, at Siegersville, 4½ miles west of Catasauqua. Lump- and wash-ore. Leased by Bethlehem Iron Company, Arenaceous, cellular; cells much filled with clay. Some of the ore is compact and fine-grained, with flaggy structure. Wash-ore carries considerable quartz.

190. *Daniel Levan's* mine, near Siegersville, 4½ miles west of Catasauqua. Wash-ore. Arenaceous, cellular; cells carrying f considerable clay.

194. *Calvin Guth's* mine, near Guthville, 4 miles west of Catasauqua. Leased by Bethlehem Iron Company. Arenaceous, cellular; some of the pieces fine-grained and flaggy. Color, various shades of brown and vermilion.

340. *Benjamin Weaver's* mine, near Guth's station, 4½ miles west of Catasauqua. Lump- and wash-ore. Compact, brittle; dark brown. Fine ore carries considerable quartz.

74. *James Kline's* mine, at Orefield, 5 miles west of Catasauqua. Lump- and wash-ore. Leased by Thomas Iron Company. Compact, flaggy, arenaceous; considerable yellow, white, and pink-tinted clay.

367. *Sheiver's* mine, 1½ miles west of Catasauqua. Lump- and wash-ore. Compact, arenaceous; also cellular. Dark brown, reddish-brown.

352. *Ruch & Brothers'* mine, at Ruchsville, 3 miles northwest of Catasauqua. Lump- and wash-ore. Cellular, botryoidal, with considerable clay. Wash-ore carries a good deal of quartz.

189. *Jonas Biery's* mine, about 4 miles northwest of Allentown. Exceedingly sandy; somewhat cellular, with considerable free quartz and clay. a

357. *Charles Glick's* mine, 3½ miles northwest of Emaus. Lump-ore. Leased by Allentown Iron Company. Compact; also cellular, with considerable adhering clay; color, dark brown.

368. *Solomon Kehm's* mine, 2½ miles northwest of Emaus. Lump-ore. Hard, compact, and tough; carries some particles of quartz and considerable adhering clay.

355. *John Roth's* mine, 3 miles north of Emaus. Lump-ore. Exceedingly compact and fine-grained; dark brown.

366. *H. & F. Jobst's* mine, 2½ miles west of Emaus. Wash-ore. Rather compact; shelly, with a large amount of clay. (D. McCreath.)

363. *Schwartz's* mine, one-half mile south of Emaus. Lump-ore. Very hard and tough, arenaceous; dark brown.

365. *Elias Daney's* mine, 1 mile south of Emaus. Lump-ore. Leased by Coleraine Iron Company. Brittle, shelly, botryoidal; dark brown. (D. McCreath.) A sample of titaniferous iron ore found in the top clay when working this mine gave the following analysis: Fe, 38.16; Mn, .35; S, none; P, trace; CaO, .52; MgO, 3.87; Al_2O_3, 2.79; TiO_2, 32.18 per cent. b

356. *Keck & Ritter's* mine, 2 miles east of Emaus. Lump-ore. Leased by Emaus Iron Company. Compact, sandy, nodular, with specks of quartz.

361. *Trexler & Kline's* mine, three-quarters of a mile east of Emaus. Lump-ore. Compact, arenaceous; dark brown. (D. McCreath.)

362. *Henry Kline's* mine, three-quarters of a mile east of Emaus. Lump-ore. Sandy, shelly; dark brown; ore carries considerable quartz. (D. McCreath.)

358. *Jesse Kline's* mine, one-half mile east of Emaus. Lump-ore. Compact; also cellular and bomb-shell; considerable clay.

	No. 364.	Percentages.
	Per cent.	
Sesquioxide of iron	69.714	= 48.80 per cent. iron.
Sesquioxide of manganese	1.292	= 0.900 per cent. manganese.
Alumina	2.388	
Lime	0.300	
Magnesia	0.317	
Sulphuric acid	0.035	= 0.014 per cent. sulphur.
Phosphoric acid	0.448	= 0.196 per cent. phosphorus.
Water	11.340	
Insoluble residue	13.915	
	99.749	

c

364. *Conrad Seam's* mine, 1½ mile east of Emaus. Lump- and wash-ore. Hard, tough, shelly, botryoidal; reddish-brown. Ore carries considerable adhering clay. (D. McCreath.) d

	No. 968.	No. 969.	No. 970.	No. 981.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	64.428	75.714	68.785	47.000
Sesquioxide of manganese	0.982	0.228	0.207	0.889
Sesquioxide of cobalt	0.040	0.010	0.020	0.080
Alumina	2.108	1.421	2.974	3.696
Lime	0.170	0.160	0.120	0.100
Magnesia	0.288	0.288	0.288	0.418
Sulphuric acid	0.032	0.447	0.612	0.062
Phosphoric acid	1.104	1.175	0.941	0.584
Water	11.374	12.724	12.866	8.622
Insoluble residue	19.760	7.790	13.310	38.940
	100.286	99.957	100.123	100.391
Metallic iron	45.100	53.000	48.150	32.900
Metallic manganese	0.684	0.159	0.144	0.619
Sulphur	0.013	*a* 0.179	*b* 0.245	0.025
Phosphorus	0.482	*c* 0.513	0.411	0.255

e

a Duplicate sulphur determination gave 0.179.
b Duplicate sulphur determination gave 0.246.
c Duplicate phosphorus determination gave 0.514.

f

968. *David Schneider's* mine, 3 miles from Friedensville, and 7 miles southwest from Hellertown. Lump- and wash-ore. Leased by Saucon Iron Company. Generally compact and fine-grained, with considerable bomb-shell ore; the walls of the bombs being lined with dark-brown fibrous iron oxide.

969. *Widow Kurtz's* mine, near Friedensville, and 4 miles southwest from Hellertown. Pipe-ore. Leased by Saucon Iron Company. Cellular, pipe-ore, generally of a dark-brown color.

970. *Morgan Mory's* mine, near Friedensville, and 4 miles southwest from Hellertown. Lump- and wash-ore. Leased by Saucon Iron Company. Brittle, cellular; the cells for the most part filled with ochreous iron ore. Color, light- and dark-brown.

981. *G. & W. Mory's* mine, near Friedensville, and 4 miles southwest from Hellertown. Lump- and wash-ore. Leased by Saucon Iron Company. Cellular, brittle, with considerable ferruginous clay and free quartz. Color of ore, dark-brown to yellowish-brown.

a *Berks county.*—Production of limonite in census year, 161,575 tons. The following analyses and notes are from Report MM, pp. 210 to 213:

	No. 983.	No. 992.	No. 993.	No. 984.	No. 982.	No. 986.	No. 988.	No. 987.	No. 990.	No. 985.	No. 989.	No. 991.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	67.857	62.857	65.000	75.857	74.571	67.428	64.000	52.214	63.857	46.857	51.643	57.571
Sesquioxide of manganese	0.155	0.557	0.288	0.950	0.496	0.320	3.414	0.185	0.505	2.183	3.320	2.441
Sesquioxide of cobalt	Trace.	0.060	0.040	Trace.	0.020	0.020	0.040	0 010	Trace.	0.060	0.050	0.050
Alumina	3.685	3.450	3.881	1.906	2.714	3.333	2.039	3.337	3.468	4.291	4.740	3.150
Lime	0.020	0.150	0.170	0.110	0.020	0.290	0.120	0.250	0.080	0.150	0.230	0.060
b Magnesia	0.237	0.432	0.421	0.230	0.201	0.360	0.245	0.302	0.331	0.604	0.518	0.479
Sulphuric acid	0.037	0.052	0.070	0.155	0.012	0.085	0.032	0.085	0.020	0.057	0.065	0.065
Phosphoric acid	0.527	1.266	0.339	0.087	0.405	0.259	0.691	0.629	0.355	1.172	0.827	1.034
Water	12.504	12.098	11.280	12.366	12.934	11.698	12.308	10.888	11.442	11.162	11.690	11.822
Insoluble residue	15.185	19.270	18.610	7.850	8.460	16.580	17.490	32.380	20.100	32.710	20.910	23.590
	100.207	100.192	100.099	99.511	99.833	100.573	100.379	100.380	100.158	99.246	99.993	100.262
Metallic iron	47.560	44.000	45.500	53.100	52.200	47.200	44.800	36.530	44.700	32.800	36.150	40.300
Metallic manganese	0.108	0.388	0.201	0.662	0.346	0.223	2.377	0.129	0.353	1.520	2.312	1.700
Sulphur	0.015	0.021	0.028	0.062	0.005	0.034	0.013	0.034	0.008	0.023	0.026	0.026
Phosphorus	0.230	0.553	0.148	0.038	0.177	0.113	0.302	0.275	0.155	0.512	0.361	0.453

c 983. *Fleetwood Iron Company's* mine, 1 mile northwest of Mertztown, at station 2312. Lump- and wash-ore. Generally compact and fine-grained, also cellular; dark-brown.

992. *Samuel Lewis'* mine, 1½ mile northwest from Mertztown, at station 2321. Lump- and wash-ore. Compact, also cellular; full of seams of ochreous iron ore; dark-brown to yellowish-brown. Wash-ore carries considerable quartz.

993. *D. K. Kline's* mine, 2½ miles from Mertztown; Kline's corners. Lump- and wash-ore. Leased by Temple Iron Company. Compact, also cellular, with cells for the most part filled with ochreous iron ore. Color, dark-brown and yellowish-brown.

984. *Charles Miller's* mine, 3 miles northwest of Mertztown, near station 2472. Lump- and wash-ore. Cellular; full of seams of ochreous iron ore, with spangles of quartz. Generally dark-brown.

982. *E. H. Trexler's* mine, 1 mile northeast of Mertztown. Lump- and wash-ore. Generally compact and fine-grained, with admixture of fibrous iron ore. Color, dark-brown to brownish-black.

986. *Mrs. John Merkel's* mine, at Farmington, 2 miles north of Mertztown. Lump- and wash-ore. Cellular, with cells filled with clay; shows some masses of quartz. Color of ore, light- and dark-brown.

d 988. *Jonathan Ziegler's* mine, at Farmington, 2 miles north of Mertztown. Lump- and wash-ore. Cellular, brittle, dark-brown.

987. *David Ziegler's* mine, near Farmington, 3 miles north-northeast of Mertztown. Lump- and wash-ore. Leased by Temple Iron Company. General appearance very sandy; cellular; also compact and fine-grained. Carries considerable quartz. Color of ore, dark-brown and reddish-brown.

990. *William Miller's* mine, 3 miles north of Topton. Lump- and wash-ore. Arenaceous, brittle, dark-brown.

985. *D. H. Smyer's Heirs'* mine, 1 mile south from Bauers, near station 2709. Lump- and wash-ore. General appearance very sandy, with dark-brown to yellowish-brown color. Carries a small admixture of manganiferous ore.

989. *Charles Heffner's* mine, one-half mile south from Lyons. Lump- and wash-ore. Leased by Temple Iron Company. Sandy; full of seams of ochreous iron ore; compact; also cellular, with cells filled with clay. Color of ore various shades of light- and dark-brown.

991. *Clymer Iron Company's Udree* mine, 2 miles northwest of Pricetown. Lump- and wash-ore. Generally very compact and fine-grained, with conchoidal fracture and dark-brown color.

e The following eight analyses of limonite from Berks county have not before been published:

	1.	2.	3.	4.	5.	6.	7.	8.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	None.	None.	None.	.....	None.	None.	None.	None.
Sesquioxide of iron	53.893	66.178	76.357	64.535	58.928	59.392	56.071	49.142
Sesquioxide of manganese	1.447	0.930	1.189	0.248	1.851	1.334	0.650	0.216
Sesquioxide of cobalt	0.120	0.100	0.110	.....	.....	.....	.....	.....
Oxide of zinc	None.	None.	None.	.....	.....	.....	.....	.....
Alumina	2.050	1.560	1.150	2.865	3.586	3.254	3.061	3.043
Lime	0.860	0.750	0.870	0.530	0.470	0.610	0.380	0.450
Magnesia	0.612	0.439	0.443	0.580	0.583	0.533	0.533	0.558
Sulphuric acid	0.012	0.010	0.032	0.200	0.080	0.010	0.050	0.030
Phosphoric acid	0.916	0.652	0.405	0.355	1.697	0.469	0.327	0.364
Water	9.276	9.650	10.350	10.442	11.392	9.066	5.866	8.862
Silicious matter	31.000	20.050	9.290	20.040	21.200	25.000	32.920	37.050
Total	100.186	100.319	100.196	99.795	99.787	99.668	99.858	99.715
Metallic iron	37.725	46.325	53.450	45.175	41.250	41.575	39.250	34.400
Metallic manganese	1.008	0.648	0.828	0.173	1.289	0.929	0.453	0.151
Sulphur	0.005	0.004	0.013	0.080	0.032	0.004	0.020	0.012
Phosphorus	0.400	0.285	0.177	0.155	0.741	0.205	0.143	0.159
Phosphorus in 100 parts iron	1.060	0.615	0.331	0.343	1.796	0.493	0.364	0.462

f

1. *Moselem* bank, 1 mile south from Moselem. Sample, 225 pieces, taken from pile in stock-house at Keystone furnace, Reading, Pennsylvania. Ore from the two washers at old large cut, and chiefly surface-ore. a

2. *Moselem* bank. Sample, 75 pieces, from the small "Red cut" washer.

3. *Moselem* bank. Sample, 95 pieces, from the new "Separator washer" at "Red cut".

4. *Joseph Albright* bank, 2½ miles north-northeast from Topton. Sample, 98 pieces, from ore-pile.

5. *Frank Brownbeck's* mine, one-half mile southwest of Lyons. Sample, 245 pieces, from ore-pile.

6. *Benfield* bank, one-half mile north from Mertztown. Sample, 220 pieces, from ore-pile at Reading Iron Works.

7. *Shaefer* mine, near Evansville. Sample, 253 pieces, from ore-pile at Reading Iron Works.

8. *Weiler* (Dankel) bank, 1¼ miles north from Hancock station, East Pennsylvania railroad. Sample, 192 pieces, from pile at Reading Iron Works.

Lebanon county produced 5,629 tons of limonite in the census year. The following six analyses of these ores have not before been published: b

	1.	2.	3.	4.	5.	6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Bisulphide of iron	0.427	.....	.....	.....	.....	.....
Sesquioxide of iron	72.001	63.500	48.742	58.071	68.392	50.642
Sesquioxide of manganese	0.133	0.258	0.143	0.268	0.258	0.237
Alumina	0.745	3.420	2.892	1.442	2.346	3.024
Lime	0.170	0.310	0.510	0.580	0.480	0.410
Magnesia	0.371	0.601	0.605	0.443	0.475	0.634
Sulphuric acid	1.865	0.105	0.140	0.070	0.105	0.105
Phosphoric acid	0.378	0.396	0.536	0.302	0.362	0.275
Water	14.734	11.206	10.124	11.242	12.066	10.334
Silicious matter	9.330	19.710	36.140	27.710	15.390	33.890
Total	100.154	99.506	99.832	100.128	99.874	99.551
Metallic iron	50.600	44.450	34.050	40.650	47.875	35.450
Metallic manganese	0.093	0.180	0.100	0.187	0.180	0.165
Sulphur	0.974	0.042	0.056	0.028	0.042	0.042
Phosphorus	0.165	0.173	0.234	0.132	0.158	0.120
Phosphorus in 100 parts iron	0.326	0.389	0.687	0.324	0.330	0.338

c

1. *Bowman* bank (H. S. Eckert & Brother), near Cornwall, and about 4 miles south from Lebanon. Sample, 285 pieces, from ore around washer. d

2. *Groh* bank, about 3½ miles south from Prescott. Sample, 215 pieces, from small pile at washer.

3. *Strickler's* bank, 1 mile west-northwest from Achey's Corners. Sample, 156 pieces, from ore-pile at washer.

4. *Moyer's* bank, 1 mile west from Achey's Corners. Sample, 135 pieces, from loose ore around the mine.

None of the above in operation when samples were taken, August, 1881.

5. *Bucher's* bank, about 3½ miles south from Prescott. Sample, 243 pieces, from ore-pile.

6. *Yingst's* bank, three-quarters of a mile north from Achey's Corners. Sample, 225 pieces, represents the wash-ore.

Dauphin county produced 1,956 tons of limonite in the census year. The following analyses of these ores have not before been published: e

	1.	2.
	Per cent.	*Per cent.*
Sesquioxide of iron	56.285	63.785
Sesquioxide of manganese	1.107	2.225
Sesquioxide of cobalt	0.070	0.080
Alumina	2.436	0.587
Lime	0.890	1.450
Magnesia	0.346	0.418
Sulphuric acid	Trace.	0.037
Phosphoric acid	0.589	1.088
Water	10.062	11.834
Silicious matter	27.830	18.070
Total	99.615	99.574
Metallic iron	39.400	44.650
Metallic manganese	0.771	1.549
Sulphur	Trace.	0.015
Phosphorus	0.257	0.475
Phosphorus in 100 parts iron	0.652	1.063

f

1. *Swatara* bank, 3¾ miles east-southeast from Hummelstown.

2. *Derry* bank, 1½ miles south of Swatara station, Philadelphia and Reading railroad. Sample, 286 pieces, represents the clean ore, free from quartz. As mined the ore will yield from 5 to 10 per cent. less iron than is shown in the above analysis.

a *Cumberland county.*—In this county 75,915 tons of limonite were mined in the census year. The following analyses show the character of the ores (see Report MM, pp. 208 and 209, and Report M³, pp. 15 to 24):

	51.	52.	53.	54.	55.	56.	57.	58.	59.	60.	61.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	.....	.....	.....	None.	Trace.	Trace.	.....	.....	.....	.....	.....
Sesquioxide of iron	69.785	64.214	52.571	75.642	67.928	71.857	58.000	72.314	62.857	64.214	77.428
Sesquioxide of manganese	0.351	1.417	8.054	0.382	0.133	0.133	1.212	3.032	1.831	2.431	0.123
Sesquioxide of cobalt	0.420	0.040	0.230	Trace.	0.060	0.060	0.070	0.270	0.200	0.110	0.140
Alumina	1.971	2.350	1.777	1.250	2.205	2.356	2.250	2.100	1.853	2.230	1.502
b Lime	0.620	0.580	1.090	0.380	0.510	0.460	0.630	0.540	0.660	0.580	0.740
Magnesia	0.410	0.504	0.374	0.331	0.403	0.457	0.306	0.302	0.270	0.342	0.443
Sulphuric acid	0.067	0.062	0.047	0.097	0.115	0.102	0.057	0.067	0.075	0.020	0.112
Phosphoric acid	0.334	1.225	4.092	0.309	0.197	0.197	0.705	1.266	0.728	1.708	0.471
Water and organic matter	11.246	12.604	13.134	12.166	10.158	10.164	10.778	13.013	10.896	11.756	12.266
Silicious matter	14.780	16.860	18.640	9.500	17.720	13.440	25.350	7.750	20.520	15.950	6.560
Total	99.984	99.856	100.009	100.048	99.429	99.226	99.358	100.654	99.890	99.341	99.785
Metallic iron	48.850	44.950	36.800	52.950	47.550	50.300	40.600	50.620	44.000	44.950	54.200
Metallic manganese	0.245	0.987	5.620	0.266	0.094	0.094	0.844	2.111	1.275	1.693	0.086
Sulphur	0.027	0.025	0.019	0.039	0.046	0.041	0.023	0.027	0.030	0.008	0.045
Phosphorus	0.146	0.535	1.787*a*	0.131	0.086	0.086	0.308	0.553	0.318	0.746	0.206
c Phosphorus in 100 parts iron	0.298	1.190	4.856	0.247	0.180	0.170	0.758	1.090	0.722	1.659	0.308

a A duplicate determination of the phosphorus, by Mr. John M. Stinson, gave 1.778 per cent.

	62.	63.	64.	65.	66.	67.	68.	68*a*.	69.	70.	71.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	68.857	60.212	58.000	54.428	59.071	52.643	51.214	71.785	64.500	49.285	51.571
Sesquioxide of manganese	0.527	3.891	4.408	10.379	1.799	2.173	3.227	0.103	0.507	0.650	2.266
Sesquioxide of cobalt	0.240	0.130	0.340	0.520	0.240	0.280	0.210	0.070	0.230	0.040	0.260
Alumina	1.684	1.559	4.296	1.565	2.365	2.324	1.885	3.630	3.868	5.867	2.964
d Lime	0.610	0.950	0.500	0.890	0.590	0.460	0.590	0.260	0.630	0.600	0.580
Magnesia	0.328	0.771	0.627	0.418	0.504	0.468	0.468	0.194	0.630	0.972	0.385
Sulphuric acid	0.062	0.070	0.085	0.056	0.060	0.060	0.080	0.017	0.035	0.102	0.037
Phosphoric acid	3.119	0.629	1.124	0.387	1.525	0.733	0.421	1.175	1.772	0.538	2.095
Water and organic matter	11.287	11.176	11.622	11.373	11.332	10.420	9.678	11.644	12.127	10.385	11.204
Silicious matter	12.800	20.900	19.260	20.220	22.000	29.970	31.890	10.650	14.970	30.840	28.620
Total	99.514	100.288	100.262	100.236	99.486	99.531	99.663	99.528	99.269	99.279	99.982
Metallic iron	48.200	42.150	40.600	38.100	41.350	36.850	35.850	50.250	45.150	34.500	36.100
Metallic manganese	0.367	2.709	3.069	7.226	1.253	1.513	2.247	0.072	0.353	0.453	1.578
Sulphur	0.025	0.028	0.034	0.022	0.024	0.024	0.032	0.007	0.014	0.041	0.015
Phosphorus	1.365	0.275	0.491	0.169	0.666	0.320	0.184	0.513	0.774	0.235	0.915
Phosphorus in 100 parts iron	2.831	0.652	1.209	0.443	1.610	0.868	0.513	1.020	1.714	0.681	2.534

e	71*a*.	72.	73.	73*a*.	74.	75.	76.	77.	77*a*.	78.	78*a*.	79.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	67.000	62.785	54.643	69.285	64.142	61.357	64.428	49.071	45.928	58.428	52.785	69.571
Sesquioxide of manganese	1.841	0.178	3.921	1.044	2.638	0.133	0.330	6.519	4.469	3.725	1.934	0.352
Sesquioxide of cobalt	0.170	0.070	0.360	0.230	0.180	0.260	0.290	0.180	0.170	0.130	0.120	0.040
Alumina	3.910	3.546	2.010	1.141	1.130	2.555	1.749	2.368	4.677	2.861	4.980	1.560
Lime	0.210	0.380	0.150	0.670	2.010	0.530	0.590	0.500	0.500	0.500	0.610	0.350
Magnesia	0.183	0.321	0.304	0.145	0.418	0.562	0.299	0.342	0.637	0.504	0.753	0.248
Sulphuric acid	0.007	0.115	0.012	0.015	0.056	0.067	0.050	0.055	0.055	0.075	0.072	0.062
Phosphoric acid	1.852	0.199	3.144	3.708	0.898	3.188	0.403	2.471	2.425	2.081	1.695	0.870
Water and organic matter	10.870	12.874	11.312	12.298	12.035	11.668	11.200	11.674	11.814	12.186	12.240	11.796
f Silicious matter	13.370	18.860	23.550	11.270	16.180	18.960	21.020	26.370	28.800	19.290	24.360	15.090
Total	99.413	99.328	99.406	99.806	99.687	99.280	100.359	99.550	99.475	99.780	99.549	99.939
Metallic iron	46.900	43.950	38.250	48.500	44.900	42.950	45.100	34.350	32.150	40.900	36.950	48.700
Metallic manganese	1.282	0.124	2.730	0.727	1.837	0.093	0.230	4.539	3.112	2.594	1.347	0.245
Sulphur	0.003	0.046	0.005	0.006	0.022	0.027	0.020	0.022	0.022	0.030	0.029	0.025
Phosphorus	0.809	0.087	1.373	1.619	0.392	1.392	0.176	1.079	1.059	0.909	0.740	0.380
Phosphorus in 100 parts iron	1.725	0.197	3.589	3.338	0.873	3.240	0.390	3.141	3.293	2.222	2.003	0.780

51. *John H. Cressler's* bank (old "Clippinger"), 2½ miles southest of Shippensburg. Wash-ore. Sample consisted of 710 pieces taken from pile of ore at washer. a

52. *George Clever* bank, at Cleversburg. Worked by Wisegarver & Peacock. Lump- and wash-ore. Sample consisted of 315 pieces taken from ore-pile at washer.

53. *No.* 1 *Clever Mammoth* bank (now Ahl's), on Clever farm, 1¼ mile southeast of Cleversburg, Southampton township. Sample consisted of 144 pieces taken from ore lying around and in mine at different places. Bank not in operation.

54. *John Bridge's* opening, 2 miles southeast of Shippensburg. Sample consisted of 108 pieces selected from ore taken out of trial-shaft; also from ore lying near same.

55. *Calico* bank—*Coover* opening (McCormick & Co.), 3 miles northeast of Shippensburg. Wash-ore. Sample consisted of 524 pieces from ore-pile at washer; also from pile at railroad wharf.

56. *Calico* bank—*Rutherford* opening (McCormick & Co.), 3 miles northeast of Shippensburg. Wash-ore. Sample consisted of 351 pieces taken from ore lying around mine.

57. *Chestnut* bank (McCormick & Co. and Lawton & Stewart), 4 miles east of Shippensburg. Wash-ore. Sample consisted of 953 pieces taken from ore-pile at washer. Mine not in operation. b

58. *George H. Clever* bank, 1½ mile east of Cleversburg, Southampton township. Lump- and wash-ore. Sample consisted of 356 pieces taken from pile of ore prepared for shipment.

59. *Big Pond* bank (Philadelphia and Reading Coal and Iron Company), about 5 miles east of Shippensburg, or about one-half mile west of Big Pond furnace. Sample consisted of 175 pieces taken from ore found in place and lying around the three most westerly openings. Bank not in operation.

60. *Old Peach Orchard* bank (Grove & Co.), about 3 miles southwest of Centerville, or about 3 miles southeast of Jacksonville. Sample consisted of 121 pieces taken from ore in place, also from wash-ore lying around mine. Bank not in operation.

61. *Peffer* bank, 2 miles west of Papertown. Sample consisted of 152 pieces taken from ore lying around mine. Bank not in operation.

62. *Wild Cat* openings (South Mountain Mining and Iron Company), about 2½ miles southwest of Pine Grove. Sample consisted of 60 pieces selected from ore taken out of several openings or shafts.

63. *Pine Grove* ore-bank (South Mountain Mining and Iron Company), at Pine Grove furnace. Sample consisted of 154 pieces taken from ore in place at different parts of bank. Ore mined for use at Pine Grove furnace. c

64. *Laurel No.* 2 bank (South Mountain Mining and Iron Company), about 1 mile south of Laurel forge. Sample consisted of 160 pieces taken from ore-pile at bank. Bank not in operation at date of visit.

65. *Laurel No.* 1 bank (South Mountain Mining and Iron Company), at Laurel forge. Sample consisted of 112 pieces taken from ore lying in and around mine. Bank not in operation. Samples selected independently by Mr. Daniel King, superintendent Pine Grove furnace, and analyzed by him, corroborated the above results.

66. *Henry Clay No.* 3 bank (Seyfert & McManus), 2½ miles northeast of Laurel. Sample consisted of 70 pieces taken from ore lying around mine. Bank not in operation.

67. *Henry Clay No.* 2 bank (Lanigan & Wynkoop), about 2¾ miles northeast of Laurel. Henry M. Watts & Son, lessees. Sample consisted of 101 pieces taken from ore in place and also from that lying around mine. Bank not in operation at date of sampling.

68. *Henry Clay No.* 1 bank (Guiterman & Robinson), 3 miles northeast of Laurel. Mount Holly Ore Bank Company, lessees. Sample consisted of 90 pieces taken from ore lying around mine. Bank not in operation at date of sampling.

68*a*. *Henry Clay No.* 1 bank (Guiterman & Robinson), 3 miles northeast of Laurel. Mount Holly Ore Bank Company, lessees. Samples of lump-ore selected by Mr. Ethelbert Watts since bank has been operated. d

69. *Diven* tract openings (McCormick & Co.), 3½ miles northeast of Laurel. Sample consisted of 106 pieces taken from ore found at eleven different pits or trial-shafts.

70. *Koontz & Myers'* bank, about 3½ miles northeast of Laurel. Wash-ore. Sample consisted of 174 pieces selected from ore-pile. Ore from which sample was taken was prepared by the so-called "dry-washer", so that analysis practically represents the ore unwashed.

71. *Grove* bank, about one-half mile south of Hunter's Run station, South Mountain railroad. Wash-ore. Bank adjoins the Lehman No. 2 tract. Sample consisted of 410 pieces taken from ore-pile at washer.

71*a*. *Grove* bank, about one-half mile south of Hunter's Run station. Lump-ore. Sample of the lump-ore selected by Dr. E. A. Grove, at my request.

72. *J. C. Lehman No.* 2 bank (Eisenhower & Gill), about three-quarters of a mile south of Hunter's Run station, South Mountain railroad. Wash-ore. Sample consisted of 192 pieces taken from pile of ore prepared for shipment. This bank has been quite recently leased by Messrs. Henry M. Watts & Son. e

73. *Mount Holly* (Medlar) bank (Mount Holly Ore Bank Company), about 1 mile southwest of Mount Holly. Two-thirds lump- and one-third wash-ore. Sample consisted of 230 pieces taken from ore in place at different parts of bank; wash-ore from ore-pile.

73*a*. *Mount Holly* (Medlar) bank (Mount Holly Ore Bank Company), about 1 mile southwest of Mount Holly. Sample represents the dark-brown cellular lump-ore from northeast end of bank, analyzed separately.

74. *Mullen* bank, about 1 mile west of Mount Holly. One-fourth lump- and three-fourths wash-ore. Mr. Daniel King, lessee. Sample consisted of 640 pieces taken from pile of ore prepared for shipment.

75. *Strickler* bank, 1 mile east of Mount Holly, or 3 miles southwest of Boiling Springs. Sample consisted of 130 pieces taken from ore in place, also from ore lying around mine. Bank not in operation.

76. *Pepper* bank ("Old mine"), 2 miles southwest of Boiling Springs. Sample consisted of 123 pieces taken from ore lying around mine. Bank not in operation.

77. *Ege* bank (Philadelphia and Reading Coal and Iron Company), 1 mile southeast of Boiling Springs. Lump-ore. Sample consisted of 177 pieces taken from ore-pile at mine. f

77*a*. *Ege* bank (Philadelphia and Reading Coal and Iron Company), 1 mile southeast of Boiling Springs. Wash-ore. Sample consisted of 345 pieces taken from ore-pile at mine.

78. *Beltzhoover* bank (Philadelphia and Reading Coal and Iron Company), 2 miles southeast of Boiling Springs. Lump-ore. Sample consisted of 195 pieces taken from ore-pile at mine.

78*a*. *Beltzhoover* bank (Philadelphia and Reading Coal and Iron Company), 2 miles southeast of Boiling Springs. Wash-ore. Sample consisted of 320 pieces taken from ore-pile at mine.

79. *Leidig & Hoffer* bank, about 3½ miles southeast of Boiling Springs. Sample consisted of 186 pieces selected from ore lying around mine. Bank not in operation.

a The following twelve analyses of limonite from *Cumberland county* have not before been published:

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	66.857	55.285	77.571	73.000	72.142	74.000	79.214	74.000	62.928	71.000	79.214	81.500
Sesquioxide of manganese	1.376	1.095	0.361	0.372	0.186	0.403	0.185	0.320	0.237	Trace.	0.113	0.081
Sesquioxide of cobalt	0.040	.....	.....	.....	0.170	.....	0.050	.....	0.290	0.160	0.200	0.160
Alumina	2.081	1.492	0.528	0.852	1.310	2.385	0.448	1.723	2.096	2.878	0.577	0.263
Lime	1.160	0.680	0.910	0.810	0.840	0.760	0.900	0.500	2.010	1.060	1.390	1.520
Magnesia	0.609	0.526	0.558	0.389	0.374	0.457	0.389	0.526	0.515	0.497	0.497	0.389
Sulphuric acid	0.025	0.057	0.110	0.130	0.072	0.010	0.027	0.155	0.017	0.087	0.060	0.052
b Phosphoric acid	0.552	0.467	0.439	0.373	0.378	0.428	0.318	0.325	1.436	0.602	0.169	0.194
Water	12.696	10.544	12.500	11.056	11.658	9.764	11.986	12.496	10.378	12.836	10.980	11.248
Silicious matter	14.350	29.810	7.260	13.210	12.540	11.620	6.410	10.140	20.140	10.570	6.200	4.730
Total	99.746	99.956	100.237	100.192	99.670	99.827	99.927	100.185	100.047	99.690	99.400	100.137
Metallic iron	46.800	38.700	54.300	51.100	50.500	51.800	55.450	51.800	44.050	49.700	55.450	57.050
Metallic manganese	0.958	0.763	0.252	0.259	0.130	0.281	0.129	0.223	0.165	Trace.	0.079	0.057
Sulphur	0.010	0.023	0.044	0.052	0.029	0.004	0.011	0.062	0.007	0.035	0.024	0.021
Phosphorus	0.241	0.204	0.192	0.163	0.165	0.187	0.139	0.042	0.627	0.263	0.074	0.085
Phosphorus in 100 parts iron	0.514	0.527	0.353	0.319	0.326	0.361	0.250	0.274	1.423	0.529	0.133	0.148

c 1. *Gorgas* bank, one-half mile west from White Hill station, Cumberland Valley railroad. Sample, 175 pieces, from loose ore lying around opening.

2. *Raapp* bank, three-quarters of a mile west from White Hill station, Cumberland Valley railroad. Sample, 96 pieces, from loose ore around opening.

3. *Best's* bank, 2 miles east-southeast from Shiremanstown. Sample, 138 pieces, from loose ore around opening.

4. *Weaver* bank, one-half mile west from Shepardstown. Sample, 118 pieces, from loose ore around opening.

5. *Carey Ahl's* bank, 1 mile east from Carlisle. Sample, 273 pieces, taken from ore-pile at washer.

6. *Sterrett Wood's* bank, 2½ miles southeast of Carlisle. Pipe-ore. Sample, 197 pieces, from loose ore around bank.

7. *Myer's* bank, 4 miles south from Greason. Sample, 225 pieces, from ore-pile at opening and from loose ore around opening. Pipe-ore.

8. *McKeehan's* bank, 2½ miles northwest from Greason. Sample, 235 pieces, from loose ore around opening. Pipe-ore.

9. *Charles Mullen's* bank, 1 mile south-southwest from Mount Holly. Sample, 168 pieces, represents the ore from 10 trial-shafts.

10. *Shopp* bank, about 1 mile northeast from Shiremanstown. Sample, 178 pieces, from loose ore around opening.

d 11. *Heike's* bank, 2 miles north-northwest from Greason. Sample, 293 pieces, from loose ore around opening. Pipe-ore.

12. *Bear's* bank, 1½ miles north from Greason. Sample, 283 pieces, from loose ore around opening. Pipe-ore.

Franklin county.—Product of limonite in census year, 36,558 tons. The following notes and analyses are from Report MM, pp. 207 and 208, and Report M³, pp. 1 to 14:

e

	186.	432.
	Per cent.	*Per cent.*
Sesquioxide of iron	76.571	77.571
Sesquioxide of manganese	0.392	0.103
Sesquioxide of cobalt	.....	.....
Alumina	5.910	0.942
Lime	0.200	0.160
Magnesia	0.281	0.076
Sulphuric acid	0.185	0.040
Phosphoric acid	0.409	0.185
Water	10.980	10.874
Insoluble residue	6.100	9.775
Total	100.128	99.726
Metallic iron	53.600	54.300
Metallic manganese	0.273	0.072
Sulphur	0.074	0.016
Phosphorus	0.179	0.081

f

186. *Michael Good's* ore-bank, 1½ miles northwest from Fayetteville. From ore-bank back of mill (see CC, p. 247). Somewhat cellular, botryoidal; dark brown and reddish brown. (D. McC.)

432. *Michael Good's* ore-bank, 1½ miles northwest from Fayetteville. Cellular, botryoidal; brittle; light and dark brown.

	No. 3.	No. 4.	No. 5.	No. 6.	No. 6a.	No. 7.	No. 8.	No. 12.	No. 13.	No. 14.	No. 15.	No. 16.a
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	None.	None.					None.					
Bisulphide of iron										0.133		
Sesquioxide of iron	67.857	60.571	58.643	64.714	52.000	62.285	68.857	63.857	56.428	75.500	75.642	57.785
Sesquioxide of manganese	3.352	2.069	0.568	1.582	2.543	0.342	1.531	0.290	6.881	0.113	0.579	1.469
Sesquioxide of cobalt	0.200	0.130	0.030	0.170	0.280	0.280	0.390	0.510	0.390	0.120	0.180	0.130
Alumina	2.887	3.470	3.923	2.723	5.709	2.620	2.573	3.277	2.874	3.363	2.166	2.985
Lime	0.740	0.700	0.760	0.450	0.620	0.560	0.670	0.710	0.630	0.830	0.640	0.500
Magnesia	0.612	0.547	0.378	0.796	0.994	0.493	0.522	0.299	0.670	0.338	0.432	0.331
Sulphuric acid	0.130	0.112	0.157	0.120	0.137	0.012	0.175	0.135	0.105	0.197	0.065	0.072b
Phosphoric acid	0.776	0.646	1.704	0.813	0.611	3.394	0.950	1.456	1.388	0.128	0.492	0.123
Arsenic acid										0.022		
Water and organic matter	12.030	11.572	11.885	11.610	10.668	11.132	11.592	11.840	12.120	12.908	11.928	10.510
Silicious matter	11.670	19.530	22.000	16.280	26.050	18.500	12.940	17.250	18.810	6.890	8.500	25.470
Total	100.254	99.347	100.048	99.258	99.612	99.618	100.200	99.624	100.296	100.542	100.624	99.465
Metallic iron	47.500	42.400	41.050	45.300	36.400	43.600	48.200	44.700	39.500	52.912	59.950	40.450
Metallic manganese	2.334	1.441	0.396	1.102	1.758	0.238	1.066	0.202	4.791	0.079	0.403	1.023
Sulphur	0.052	0.045	0.063	0.048	0.055	0.005	0.070	0.054	0.042	0.150	0.026	0.029
Phosphorus	0.339	0.282	0.744	0.355	0.267	1.482*	0.415	0.636	0.006	0.056	0.215	0.054
Phosphorus in 100 parts iron	0.713	0.665	1.812	0.783	0.733	3.399	0.861	1.422	1.534	0.105	0.406	0.133

* Average of two determinations.

c

	No. 17.	No. 18.	No. 19.	No. 20.	No. 21.	No. 22.	No. 23.	No. 24.	No. 25.	No. 26.	No. 27.	No. 28.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	53.928	62.428	67.000	52.928	68.928	60.642	69.214	66.214	77.428	68.214	75.428	67.857
Sesquioxide of manganese	0.133	0.237	0.135	0.558	0.258	3.652	2.287	1.825	0.817	1.252	0.889	2.266
Sesquioxide of cobalt	0.190	Trace.	0.160	0.090	0.240	0.250	0.250	0.220	0.370	0.280	0.260	0.070
Alumina	1.980	1.500	1.567	3.035	1.927	2.695	1.605	2.126	1.243	1.182	1.366	2.663
Lime	0.600	0.110	0.780	0.590	0.570	0.760	0.650	0.510	0.600	0.670	0.730	0.360
Magnesia	0.576	0.395	0.371	0.450	0.230	0.681	0.486	0.490	0.324	0.252	0.414	0.353
Sulphuric acid	0.065	0.087	0.032	0.055	0.188	0.110	0.047	0.065	0.169	0.100	0.070	0.047
Phosphoric acid	1.074	0.602	1.012	0.950	1.005	0.643	0.501	0.540	0.229	0.774	0.432	0.160d
Water and organic matter	8.858	9.392	10.102	9.665	10.656	11.065	11.515	10.920	10.607	11.860	11.780	11.284
Silicious matter	32.560	25.570	18.250	31.700	15.200	18.870	13.070	16.750	7.870	14.990	8.920	14.510
Total	99.964	100.321	99.409	100.021	99.502	99.368	99.625	99.660	99.657	99.574	100.289	99.570
Metallic iron	37.750	43.700	46.900	37.050	48.250	42.450	48.450	46.350	54.200	47.750	52.800	47.500
Metallic manganese	0.093	0.165	0.094	0.389	0.180	2.543	1.592	1.271	0.569	0.872	0.619	1.578
Sulphur	0.026	0.035	0.013	0.022	0.075	0.044	0.019	0.026	0.067	0.040	0.028	0.019
Phosphorus	0.469	0.261	0.442	0.415	0.439	0.281	0.219	0.236	0.100	0.338	0.189	0.070
Phosphorus in 100 parts iron	1.242	0.601	0.942	1.120	0.909	0.661	0.452	0.509	0.184	0.708	0.357	0.147

	No.29.	No. 30.	No. 31.	No. 32.	No. 33.	No. 34.	No. 35.	No. 36.	No. 37.	No. 38.	No. 39.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.* e
Sesquioxide of iron	67.642	68.642	73.714	66.071	69.428	72.214	54.785	68.714	75.000	61.285	78.000
Sesquioxide of manganese	1.075	2.545	0.082	0.620	3.094	0.441	4.501	3.694	0.952	0.775	0.483
Sesquioxide of cobalt	0.160	Trace.	Trace.	0.120	0.320	Trace.	0.230	0.170	0.050	Trace.	Trace.
Alumina	1.458	3.250	1.650	2.629	1.627	1.644	4.381	1.605	2.150	3.143	1.982
Lime	0.700	0.740	0.830	0.630	0.800	0.940	0.280	0.830	0.480	0.720	0.470
Magnesia	0.166	0.309	0.137	0.295	0.277	0.324	0.454	0.299	0.216	0.306	0.248
Sulphuric acid	0.165	0.040	0.030	0.082	0.120	0.135	0.037	0.092	0.047	0.022	0.092
Phosphoric acid	0.451	0.252	0.229	1.000	0.135	0.362	1.944	0.091	0.261	1.062	0.238
Carbonic acid							0.046	None.	None.		
Water and organic matter	11.586	11.692	11.522	12.062	12.062	12.630	11.742	11.200	11.812	10.788	12.610
Silicious matter	16.020	12.100	11.910	15.940	11.680	11.520	21.510	12.790	9.110	21.480	5.775
Total	99.423	99.571	100.104	99.449	99.543	100.210	99.910	99.485	100.078	99.581	99.898f
Metallic iron	47.350	48.050	51.600	46.250	48.600	50.550	38.350	48.100	52.500	42.900	54.600
Metallic manganese	0.749	1.772	0.057	0.432	2.154	0.309	3.134	2.572	0.663	0.540	0.336
Sulphur	0.066	0.016	0.012	0.033	0.048	0.054	0.015	0.036	0.019	0.009	0.037
Phosphorus	0.197	0.110	0.100	0.437	0.059	0.157–.158	0.849	0.040	0.114	0.464	0.104
Phosphorus in 100 parts iron	0.416	0.228	0.193	0.944	0.121	0.312	2.213	0.083	0.217	1.081	0.190

a	No. 40.	No. 41.	No. 42.	No. 43.	No. 44.	No. 45.	No. 46.	No. 47.	No. 48.	No. 49.	No. 50.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	.....	.....	.....	.....	Trace.	Trace.	Trace.	.....	.....	.....	.....
Sesquioxide of iron	68.517	78.500	75.714	78.785	64.214	55.142	67.142	65.071	53.142	62.500	69.214
Sesquioxide of manganese	0.685	0.465	0.681	0.235	1.728	1.002	1.809	1.045	2.358	1.947	2.917
Sesquioxide of cobalt	Trace.	0.210	0.010	0.030	0.050	0.070	0.090	0.110	0.080	0.110	0.570
Alumina	2.968	1.754	1.968	0.550	2.100	1.625	1.471	3.150	5.352	3.664	1.511
Lime	0.440	0.530	0.350	0.730	0.380	0.370	0.500	0.280	0.580	0.790	0.480
Magnesia	0.349	0.227	0.216	0.281	0.396	0.138	0.183	0.360	0.756	0.558	0.288
Sulphuric acid	0.092	0.092	0.067	0.060	0.100	0.072	0.075	0.032	0.072	0.070	0.032
b Phosphoric acid	0.250	0.199	0.268	0.261	0.316	0.407	0.678	1.578	1.406	1.216	0.575
Water and organic matter	12.190	12.440	11.760	11.222	10.812	11.078	12.004	11.660	11.468	12.360	11.838
Silicious matter	14.320	4.950	8.770	7.780	19.470	29.970	15.650	16.460	24.250	16.680	13.270
Total	99.811	99.367	99.204	99.934	99.566	99.874	99.602	99.746	99.464	99.895	100.695
Metallic iron	47.962	54.950	53.000	55.150	44.950	38.600	47.000	45.550	37.200	43.750	48.450
Metallic manganese	0.477	0.324	0.057	0.165	1.203	0.698	1.260	0.728	1.642	1.356	2.031
Sulphur	0.037	0.036	0.027	0.024	0.040	0.029	0.030	0.013	0.029	0.028	0.013
Phosphorus	0.109	0.087	0.117	0.114	0.138	0.178	0.296	0.689	0.614	0.531	0.251
Phosphorus in 100 parts iron	0.227	0.158	0.220	0.206	0.307	0.461	0.629	1.512	1.650	1.213	0.518

3. *Old Mount Pleasant* bank, near Richmond furnace. Lump- and wash-ore. Sample consisted of 445 pieces taken from pile of ore
c prepared for shipment.

4. *Beaver* bank, about 2 miles northwest of Richmond furnace. Lump- and wash-ore. Sample consisted of 450 pieces taken from pile of ore prepared for shipment.

5. *Jennings Jones'* bank, 4 miles north of Richmond furnace. Sample selected by Mr. William Burgess, consisted of 30 pieces taken from different parts of mine.

6. *Old Carrick Furnace* bank, 1¾ miles west of Fannettsburg, Metal township. Lump-ore. Sample consisted of 149 pieces taken from ore-pile at furnace.

6a. *Old Carrick Furnace* bank. Unwashed fine ore. Sample consisted of 185 pieces taken from ore-pile at furnace.

7. *Railroad* bank, about 1¾ miles west of Fannettsburgh, Metal township, 200 feet north of Old Carrick Furnace bank. Sample consisted of 78 pieces taken from ore-pile at furnace.

8. *George Weinman's* bank, 1½ mile northwest of Fannettsburgh, Metal township. Surface-ore. Sample consisted of 156 pieces taken from ore found around opening.

12. *Webster* bank (Smith, Duncan & Avery), 2 miles west-northwest of Mercersburg. Sample consisted of 83 pieces taken from ore-
d pile at bank.

13. *Squire Stinger's* old bank, 1 mile east of Loudon, Peters township. Sample consisted of 138 pieces taken from dump of five or six shafts.

14. *Garlick* bank, 2½ miles southwest of Saint Thomas. Sample consisted of 63 pieces taken from ore found around opening.

15. *Robert McCleary's* bank, 1½ mile north of Mount Hope, Quincy township. Sample consisted of 244 pieces taken from ore lying around bank.

16. *George Rock's* bank, 3 miles south of Mont Alto, or 1 mile southeast of Quincy. Sample consisted of 63 pieces taken from ore in place at different parts of the bank. Mine not in operation at date of visit. Bank about 50 feet in diameter, and from 4 to 10 feet deep.

17. *Pass Orchard* bank, 1½ mile east of Quincy, in Bissecker gap, Mont Alto estate. Sample consisted of 165 pieces taken from ore at various pits sunk prior to 1864. Bank not worked.

18. *Wyeth Douglas* bank, 1 mile northeast of Quincy, near Mount Airy. Sample, selected by Mr. A. E. Lehman, consisted of several large pieces. No fresh sample was taken from this bank, as upon examination it was thought that the above analysis, made in 1879, fairly
e represented the character of ore.

19. *David Mentzer* opening, 1½ mile southwest of Altodale (Funkstown). Sample consisted of 91 pieces selected from ore lying around openings.

20. *Smith, Duncan & Avery's* bank, 1 mile west of Mont Alto. Lump- and wash-ore. Sample consisted of 478 pieces taken from ore-pile as prepared for shipment. Mine worked by open cut. Has probably shipped over 5,000 tons ore.

21. *Mill* bank (Mont Alto Iron Company), about 300 yards west of furnace at Mont Alto. Sample consisted of 125 pieces taken from ore-pile at washer. This bank is an open excavation, 20 feet deep from surface, 60 by 80 feet. About 1,500 tons of ore mined from it prior to January, 1881.

22. *Mine No.* 3 (Mont Alto Iron Company), one-fourth mile east of Mont Alto furnace. Sample consisted of 200 pieces taken from ore in place at different parts of shaft. Mine both open and underground work. Opened prior to 1864, but idle from 1865 to 1879. Capacity, about 70 tons per day.

23. *Mine No.* 4 (Mont Alto Iron Company), three-fourths mile east-northeast of Mont Alto furnace. Sample consisted of 210 pieces taken from pile of ore mined for furnace-use at Mont Alto. This mine is both open and underground work. It has supplied over 100,000 tons of ore to Mont Alto furnace. Deepest point of work below surface, 230 feet; length of mine, 1,800 feet; width of mine, 35 feet.

24. *Mine No.* 5 (Mont Alto Iron Company), three-fourths mile east-northeast of Mont Alto furnace. Sample consisted of 75 pieces
f taken from ore lying around mine. This mine is worked both open and underground; worked to 50 feet deep from surface. Has furnished about 5,000 tons of ore.

25. *Mine No.* 8 (Mont Alto Iron Company), 1¼ mile north, 38° east, from Mont Alto furnace. Sample consisted of 197 pieces taken from pile of ore at mine. Excavation 200 feet long, 50 feet wide, and 25 feet deep.

26. *Benjamin George* deposit, 1¼ mile northeast of Altodale. Surface-ore. Sample consisted of 41 pieces selected from surface-ore of deposit.

27. *John Small* bank, 1¾ mile north of Mont Alto furnace; 500 yards east of the Shiery farm. Sample consisted of 74 pieces taken from ore lying around opening. Open excavation 35 feet long, 25 feet wide, and 10 feet deep. Product about 250 tons.

28. *Thomas Calliman* bank, about one-half mile east from Pond No. 1 bank. Sample consisted of 75 pieces taken from ore lying around openings. Four pits sunk on this deposit to test the quantity and quality. No large quantity mined. a

29. *Jacob Rock's* bank, 3 miles north of Mont Alto furnace. Lump- and wash-ore. Sample consisted of 288 pieces taken from pile of ore prepared for shipment. Mine worked by a shaft 105 feet deep. Has furnished about 2,000 tons of ore.

30. *Lucy* mine (Mont Alto Iron Company), 2½ miles north from Mont Alto. Sample consisted of about 50 pieces taken from ore mined from a number of test-pits. Private analysis made for Mont Alto Iron Company, and published by permission of Mr. George B. Wiestling, superintendent.

31. *Ruth* mine (Mont Alto Iron Company), one-half mile west of the Lucy mine. Sample consisted of about 50 pieces taken from ore mined from various test-pits. Private analysis published by permission of Mr. George B. Wiestling, superintendent Mont Alto iron-works.

32. *McNeal* bank (McCormick & Co.), about 3 miles north of Mont Alto. Sample consisted of 131 pieces taken from ore lying at opening and near it. Mine not in operation.

33. *Pond No.* 2 bank, 3 miles north-northeast of Mont Alto, on Mont Alto estate. Sample consisted of 218 pieces taken from ore lying around mine. Mine not in operation at date of visit. Open excavation 110 feet by 90 feet, and about 10 feet deep. Worked prior to 1864, and ore used at Mont Alto furnace. Since 1864 a shaft was sunk and about 2,000 tons of ore mined at depth of 90 feet from surface. b

34. *Pond No.* 1 bank, 3 miles north-northeast of Mont Alto, on Mont Alto estate. Sample consisted of 175 pieces taken from ore lying around mine. Not in operation at date of visit; 163 pieces selected by Mr. George B. Wiestling since mine has been operated gave—Metallic iron, 48.500; phosphorus, 0.149; water, 11.935; silicious matter, 13.930; phosphorous in 100 parts iron, 0.306. This is an open excavation 300 by 150 feet, and varying in depth from 8 to 30 feet. Quantities of ore were mined here prior to 1864. Laid idle from 1864 until the fall of 1880, when work recommenced.

35. *English* mine, 2 miles southeast of Greenwood. Sample consisted of 138 pieces taken from ore in place at various parts of mine. Opening about 150 by 100 feet by 20 feet deep.

36. *Lime Kiln* bank, 2½ miles north of Mont Alto furnace. Sample consisted of 125 pieces taken from ore lying around opening. Open and underground. Open work say 25 feet diameter and 8 feet deep; underground 40 feet deep. Probably about 400 tons taken from mine.

37. *Guilford* bank, 2½ miles south of Greenwood, 2½ miles northeast of Altodale, or 2½ miles north, 25° east of Mont Alto. Sample consisted of 128 pieces taken from ore lying in and around bank. Open excavation 75 feet long, 30 feet wide, and 18 feet deep. This is surrounded with probably 10 test-pits. c

38. *Hope* mine (Mont Alto Iron Company), 200 yards west of the Promise mine, or about 3 miles north, 20° east of Mont Alto. Sample consisted of about 50 pieces taken from ore-pile mined from pits to test quality. Private analysis made by me for Mont Alto Iron Company, and published by permission of Mr. George B. Wiestling, superintendent.

39. *Promise* mine (Mont Alto Iron Company), 3 miles north, 20° east from Mont Alto. Sample consisted of about 50 pieces taken from ore mined to test quality. Worked open and underground 40 feet deep. Private analysis published by permission of Mr. George B. Wiestling, superintendent of Mont Alto iron-works.

40. *White Rock* mine (Mont Alto Iron Company), 2½ miles north, 20° east from Mont Alto. Sample consisted of about 50 pieces taken from several pits or shafts over an area of say 2,000 feet square. Private analysis published by permission of Mr. George B. Wiestling.

41. *Wiestling* mine, 3 miles north, 25° east of Mont Alto, or 1½ mile south of Greenwood. Sample consisted of 99 pieces selected from ore taken out of several pits or shafts sunk to test quantity and quality. d

42. *William L. Chamber's* opening, on farm about 1 mile north of Scotland. Sample consisted of 75 pieces taken from surface ore near shaft.

43. *Ahl's* bank, 1½ mile southwest of Shippensburg, Southampton township. Pipe-ore. Sample consisted of 115 pieces taken from ore lying around and in opening. Bank not in operation.

44. *McHose* bank (old "Neikirk" bank), 3 miles west-southwest of Shippensburg. Wash-ore. Sample consisted of 227 pieces taken from pile of ore at washer.

45. *Joseph Cressler* bank, about 3 miles south-southwest of Shippensburg, Southampton township. Wash-ore. Sample consisted of 878 pieces taken from pile of ore at washer.

46. *Jacob Koser* bank, about 3 miles south-southwest of Shippensburg, Southampton township. Wash-ore. Sample consisted of 325 pieces taken from pile of ore at washer. This is the same opening as the Joseph Cressler bank, but ore is mined from a higher level.

47. *Old Southampton* bank, 3 miles south of Shippensburg, on old furnace property. Owned by George H. Stewart. Leased to Moses Taylor, New York. Sample consisted of 213 pieces taken from ore lying around mine. Bank not in operation.

48. *Ruby* or *Plaster* bank, 3½ miles south of Shippensburg, near Old Southampton furnace. Sample consisted of 275 pieces taken from ore lying around mine. Bank not in operation. e

49. *Gochenauer & Rohrer* bank, 3 miles south of Shippensburg, on Clever farm, near Old Southampton furnace. Sample consisted of 160 pieces taken from ore lying around mine. Bank not in operation at date of visit.

50. *Means* bank, about 3 miles southeast of Shippensburg, near county line. Sample consisted of 121 pieces taken from ore dump. Bank not in operation.

Montgomery county.—Production of limonite in census year, 94,387 tons. No analyses of the limonite from this county have yet been published by the Second Geological Survey.

Chester county.—Production of limonite in census year, 5,031 tons. No analyses of this ore are available.

Lancaster county.—Production of limonite in census year, 78,850 tons. The following analyses are from Report MM, pp. 209 and 210: f

	No. 642.	No. 651.	No. 652.	No. 641.	No. 797.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	64.571	78.571	78.857	76.428	76.714
Sesquioxide of manganese	1.450	0.657	1.302	1.456	0.723
Sesquioxide of cobalt	0.185	0.130	0.047	0.066	0.045
Alumina	2.633	2.367	2.112	1.260	2.791
Lime	0.054	0.170	0.210	0.230	0.030
Magnesia	0.047	0.187	0.335	0.147	0.198
Sulphuric acid	0.008	Trace.	0.095	0.008	0.027
Phosphoric acid	1.026	0.847	0.581	0.602	1.475

	No. 642.	No. 651.	No. 652.	No. 641.	No. 642.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	10.970	12.468	12.075	12.733	13.472
Insoluble residue	19.015	4.770	4.765	7.290	4.385
Total	99.959	100.167	100.379	100.220	99.860
Metallic iron	45.200	55.000	55.200	53.500	53.700
Metallic manganese	1.010	0.457	0.908	1.015	0.504
Sulphur	0.003	Trace.	0.038	0.003	0.011
Phosphorus	0.448	0.370	0.254	0.263	0.644

a 642. *Chestnut Hill* ore-mines, about 3 miles northeast from Columbia. Mined by Chickies Iron Company in the bank of Edward B. Grubb's heirs. From eastern series of mines; one-third lump, two-thirds fine ore. Generally compact and fine-grained, but with numerous cavities filled with ochreous iron ore. Bombshell ore lined with fibrous, botryoidal brown oxide of iron. Fine ore carries considerable quartz.

651. *Chestnut Hill* ore-mines; mined by Chickies Iron Company in the bank of Edward B. Grubb's heirs. All lump-ore. Stalactites; bombshell ore, with fibrous, botryoidal brown oxide of iron. Specimens show some specks of quartz. Color, generally dark brown.

652. *Chestnut Hill* ore-mines; Clement B. Grubb's bank. All lump-ore. A mixture of bombshell ore, with walls of shell lined with fibrous iron oxide with velvety surface; and cellular, dull earthy-looking ore. Portions of the ore have a distinctly laminated structure. Generally coated with a yellowish-white clay.

641. *Chestnut Hill* ore-mines; Chestnut Hill Iron Company's bank; C. J. Nourse, superintendent. One-fourth fine ore; three-fourths lump-ore. Nodular; stalactitic; bombshell; with considerable fibrous brown oxide of iron. Color, generally dark brown. Some masses of
b quartz throughout specimens.

797. *Chestnut Hill* ore-mines; float-ore from Chestnut Hill Iron Company's bank. Fibrous, brittle; dark brown.

York county.—The limonites of York county are of more than one age. Some of the deposits occur at the contact of the slates and limestones of Formation II, while others are the "decomposed outcrops of the ferriferous beds in the Azoic rocks". In Report MM, Mr. McCreath has collected their analyses under a different heading from that of the limonites of Formation II; but it appears from the position of the mines that the greater part of the limonite produced in this county in the census year came from this formation, so that in these notes it seems as well to include them under this head. York county produced 28,165 tons of limonite in the census year. The following notes and analyses are from Report MM, pp. 220 to 221, and Report M³, pp. 24 to 26:

c

	No. 111.	No. 353.	No. 429.
	Per cent.	*Per cent.*	*Per cent.*
Sesquioxide of iron	65.000	60.857	56.143
Sesquioxide of manganese	1.712	2.638	0.201
Alumina	2.355	1.912	2.321
Lime	0.390	0.160	0.140
Magnesia	0.356	0.407	0.324
Sulphuric acid	0.105	0.057	0.073
Phosphoric acid	3.295	2.691	0.616
Water	11.790	11.560	6.286
Insoluble residue	14.880	19.115	34.330
Total	99.883	99.397	100.434
d			
Metallic iron	45.500	42.600	39.300
Manganese	1.192	1.837	0.139
Sulphur	0.042	0.023	0.027
Phosphorus	1.439	1.175	0.269

111. *Henry L. Bauman's* ore-bank, one-half mile east of York Road station, Hanover Junction railroad. *Sprenkel's* opening. See Report C, p. 39. Arenaceous, seamed with quartz; dark brown. (D. McC.)

353. *Henry L. Bauman's* ore-bank, one-eighth mile east of York Road station, Hanover Junction railroad. *Kraber & Ness'* opening. See Report C, p. 40. Arenaceous, brittle; seamed with quartz; ore carries considerable argillaceous slaty gangue. Color, generally dark brown.

e 429. *Bollinger's* bank, at Kaufman's siding, one-fourth mile east from York Road station, Hanover Junction railroad. See Report C, p. 38. Compact, brittle; carries a large amount of adhering yellow and white clay. Color, various shades of red and brown.

Adams county.—Only 560 tons of iron ore was produced in this county in the census year. This was limonite, and was mined near Littlestown; it probably belongs to Formation II.

Clinton county.—No ore was mined in this county in the census year. The following analyses are from Report M³, p. 44. The ore is referred, provisionally, to Formation II:

f

	No. 136.	No. 137.		No. 136.	No. 137.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sesquioxide of iron	77.071	74.785	Water and organic matter	12.650	11.978
Sesquioxide of manganese	0.030	0.030	Silicious matter	8.380	9.780
Sesquioxide of cobalt	Trace.	Trace.	Total	99.945	100.003
Alumina	0.593	2.053			
Lime	0.630	0.640	Metallic iron	53.950	52.350
Magnesia	0.468	0.508	Metallic manganese	0.021	0.021
Sulphuric acid	0.087	0.097	Sulphur	0.035	0.039
Phosphoric acid	0.036	0.132	Phosphorus	0.016	0.058
			Phosphorus in 100 parts iron	0.029	0.110

136. *Salona* ore-bank, Nittany valley, Porter township. Lump- (kidney) ore.

137. *Salona* ore-bank, Nittany valley, Porter township. Wash-ore. Limonite, botryoidal; dark brown; small masses of quartz throughout specimens.

Centre county.—Product in census year, 8,935 tons. The ore was mined principally from the vicinity of the a Eagle and Howard furnaces. The following analyses, from Report T_4, pp. 142 and 178, show the character of the census year's product.

	No. 1.	No. 2.
	Per cent.	*Per cent.*
Sesquioxide of iron	56.642	75.821
Sesquioxide of manganese	0.288	0.258
Alumina	1.470	0.830
Lime	2.520	0.500
Magnesia	1.131	0.724
Sulphuric acid	0.052	0.077
Phosphoric acid	0.236	0.329
Water	10.932	12.340
Insoluble residue	24.020	9.330
Total	100.291	100.229
Iron	41.750	53.075
Manganese	0.201	0.180
Sulphur	0.021	0.031
Phosphorus	0.103	0.144
Phosphorus in 100 parts iron	0.246	0.271

b

1. *Curtin Brothers' Fishing Creek* bank. Sample consisted of 10 pounds of ore, and was collected in 1881. c
2. *Howard* bank, three-eighths of a mile northeast of Hecla. Sample consisted of 20 pounds of ore.

Huntingdon county.—Limonite has been mined in this county at the following geological horizons: Siluro-Cambrian (Formation II), Medina (Formation IV), Lower Helderberg and Oriskany (Formations VI and VII), Marcellus (Formation VIII), and Mauch Chunk Red Shale (Formation XI). In the census year a total of 10,186 tons were produced, and of this 10,080 tons were mined in Warriors' Mark township (in the northeastern corner of the county) from the Siluro-Cambrian. Reference will be made hereafter to the ores of the younger formations.

Blair county.—In this county, as in Huntingdon, limonite occurs at several geological horizons. The ores of Formation II are, however, by far the most important; and, with the exception of 6,720 tons from the S. C. Baker mine, in Logan township, from the Lower Helderberg limestone, it is probable that no limonite was mined in the census year in this county from any other horizon. In the census year 114,278 tons of limonite were produced in d the county. The following notes and analyses are from Report MM, pp. 199 to 206:

	No. 565.	No. 566.	No. 567.	No. 788.	No. 789.	No. 603.	No. 466.	No. 640.	No. 644.	No. 639.	No. 583.	No. 468.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	60.000	63.571	69.428	79.714	80.428	78.428	78.428	62.714	70.143	72.857	75.571	78.143
Bisulphide of iron	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.024
Sesquioxide of manganese	3.517	0.933	0.270	0.061	0.184	0.102	0.350	0.345	0.123	0.173	0.081	0.103
Sesquioxide of cobalt	.....	.....	.....	None.	None.	Trace.	Trace.	Trace.	Trace.	Trace.	.....	Trace.
Alumina	2.321	3.796	1.891	1.320	1.636	2.204	1.886	2.655	2.069	3.239	3.426	2.146
Lime	0.270	0.390	0.270	0.260	0.460	0.050	0.030	0.350	0.020	0.320	0.680	0.030
Magnesia	0.398	0.302	0.610	0.392	0.508	0.511	0.097	0.292	0.158	0.338	0.673	0.493
Sulphuric acid	0.162	0.091	0.092	0.030	0.050	0.025	0.060	Trace.	Trace.	Trace.	Trace.	0.147 e
Phosphoric acid	0.822	2.153	1.021	0.224	0.286	0.174	0.396	0.311	0.238	0.504	0.513	0.137
Water	11.138	12.620	12.364	11.050	11.700	11.958	11.248	10.113	10.213	11.391	12.595	11.886
Insoluble residue	20.590	15.930	13.660	7.560	5.165	5.700	7.410	23.450	17.240	11.325	7.010	6.845
Total	99.218	99.786	99.615	100.611	100.507	99.152	99.911	100.230	100.204	100.147	100.549	99.954
Metallic iron	42.000	44.500	48.600	55.800	56.300	54.900	54.900	43.900	49.100	51.000	52.900	54.710
Metallic manganese	2.449	0.650	0.191	0.043	0.128	0.072	0.248	0.240	0.085	0.120	0.057	0.072
Sulphur	0.065	0.036	0.037	0.012	0.020	0.010	0.024	Trace.	Trace.	Trace.	Trace.	0.072
Phosphorus	0.359	0.940	0.446	0.098	0.125	0.076	0.173	0.136	0.104	0.220	0.224	0.060

565. *Henrietta* mines, 4 miles southeast from Martinsburg. Mine No. 1; the large open cut. Sample taken from washed-ore pile. Ore from top of Formation No. II in Utica slate. Nearly all fine ore; sandy, brittle; dark brown.

566. *Falkner* ore-shaft, south of Henrietta mine, in Leathercracker Cove. Lump-ore taken from pile. Top of Formation No. II. f Compact, botryoidal, with velvety surface; light brown and reddish brown.

567. *Hoover* bank, 1 mile south of Henrietta main mine. Hoover open cut. Top of Formation No. II. Compact, with laminated structure; also cellular, with considerable yellow and white clay in cells; color, dark brown and reddish brown.

788. *Robeson Farm* ore-bank, 2 miles south-southwest from Birmingham station. Outcrop-ore. Cellular, brittle; dark brown and yellowish-brown. Some masses of quartz throughout specimens.

789. *Clark Farm* ore-bank, near Etna furnace. Cellular, brittle; dark brown.

603. *Ore bank* near Etna furnace, Catherine township, Canoe valley. Stalactitic, botryoidal; somewhat coated with a yellowish clay; color, generally dark brown.

466. *Short Mountain* mines, Catharine township, 1½ miles northwest from Franklin forge. Etna Iron-Works; Isett & Brothers. Compact; also cellular, botryoidal, mammillary, with radiated, fibrous, brown oxide. Generally hard and tough, with light and dark brown color.

a	No. 467.	No. 526.	No. 525.	No. 643.	No. 604.	No. 606.	No. 607.	No. 612.	No. 963.	No. 973.	No. 608.	No. 609.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	84.428	73.714	52.428	74.143	65.713	78.000	77.143	76.214	59.428	69.857	72.143	51.571
Bisulphide of iron	0.004	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sesquioxide of manganese	0.368	0.610	1.344	0.265	0.551	0.195	0.093	0.011	1.758	0.509	1.273	0.548
Sesquioxide of cobalt	Trace.	Trace.	.....	.....	.....	Trace.	.....	.....	.....	.....	0.011	Trace.
Alumina	2.617	1.979	2.042	3.019	3.908	2.348	2.438	2.491	3.024	3.176	2.457	3.996
Lime	0.070	Trace.	Trace.	0.150	0.240	0.220	0.130	0.020	0.080	0.130	0.170	0.075
Magnesia	0.227	0.309	0.129	0.255	0.200	0.396	0.464	0.386	0.331	Trace.	0.457	0.209
Sulphuric acid	0.237	0.072	0.075	Trace.	0.115	0.102	0.041	0.020	0.062	0.138	0.135	0.057
Phosphoric acid	0.123	0.137	0.080	0.238	0.219	0.462	0.194	0.259	0.128	0.057	0.103	0.185
b Water	8.672	10.510	9.375	10.865	11.876	11.880	10.164	12.486	8.795	10.280	11.276	9.811
Insoluble residue	3.460	12.260	34.700	11.360	17.560	6.805	9.260	7.470	25.855	16.350	11.970	32.830
Total	100.206	99.591	100.173	100.295	100.382	100.408	99.927	99.357	99.461	100.497	99.995	99.282
Metallic iron	59.100	51.600	36.700	51.900	46.000	54.600	54.000	53.350	41.600	48.900	50.050	36.100
Metallic manganese	0.256	0.425	0.936	0.181	0.384	0.136	0.065	0.007	1.224	0.353	0.886	0.382
Sulphur	0.096	0.029	0.030	Trace.	0.046	0.041	0.017	0.008	0.025	0.055	0 054	0.023
Phosphorus	0.054	0.060	0.035	0.104	0.096	0.202	0.085	0.113	0.056	0.025	0.045	0.081

640. *Brower* mine, 2½ miles northwest of Williamsburg. Compact, fine-grained, jaspery, brittle; reddish-brown and liver-brown.

644. *Patterson* mine, 1 mile south from Williamsburg. Compact, brittle, arenaceous, with masses of quartz throughout the specimen.

c Color of ore, dark brown.

639. *Red Bank* mine, 2 miles south from Williamsburg. Generally cellular, with cells partially filled with reddish-brown ochreous earth. Comparatively soft; reddish brown, showing spangles of quartz.

583. *Dean's* mine, 2 miles southeast of Williamsburg, Woodberry township. Cellular, with cells filled with a yellow clay; generally dark brown. (D. McCreath.)

468. *Springfield* mines, 1 mile south of Springfield. Bank No. 3, two-thirds of a mile west of bank No. 2. Lump- and wash-ore. Nodular, cellular, with cells partially filled with a yellow clay. Shows small kernels of pyrite, without crystalline form; also rhombic dodecahedron crystals of hydrous iron oxide. Color of ore generally dark-brown.

467. *Springfield* mines, bank No. 2, Lykens mine, one-half mile south of bank No. 1. Bombshell-ore. Bombshell-ore, the bombs partially filled with clay and lined with fibrous, botryoidal iron oxide. Exceedingly hard and tough; dark brown and reddish brown.

526. *Springfield* mines, bank No. 2. Ore as taken from washer and used by Cambria Iron Company. Specimen consists of small masses of brown hematite iron ore with admixture of bombshell-ore. (D. McCreath.)

525. *Springfield* mines, bank No. 1, generally known as Davis' bank. At north end of line of mines. Wash-ore. Lump- and fine-

d ore; structure of lumps somewhat laminated. Fine ore carries considerable quartz. (D. McCreath.)

643. *McPheese* bank, 1½ mile south of Springfield. Brittle, argillaceous; somewhat cellular; dark brown and reddish brown.

604. *Rebecca* mine, 4 miles northeast of Henrietta post-office. Brittle, arenaceous; cellular, with cells lined with göthite; considerable adhering white clay. Color of ore generally light brown.

606. *Thompson* mine, 2 miles west from Fredericksburg. Cellular, nodular, brittle; dark brown.

607. *Red Ore* bank, one-third mile from Millerstown. Ore for the most part coated with a reddish-brown clay; exceedingly hard and tough. On fresh fracture the color is dark brown.

612. *Soister* mine, 3½ miles north from Woodberry, near county line. Abandoned mines. Exceedingly hard and tough; generally very compact; carries considerable quartz. Color, various shades of dark brown, reddish brown, and vermilion.

963. *Sarah Furnace* ore-bank (Springfield mines), about 2 miles south of Springfield. Hard and tough, with considerable quartz; color dark brown and brownish black; fracture irregular, rough.

973. *Sarah Furnace* ore-bank, about 2 miles south of Springfield. So-called "burnt ore." Somewhat cellular, with considerable

e quartz; dark brown to reddish brown. (S. S. Hartranft.)

608. *Bloomfield* mines, about 3 miles south from Roaring Springs. Lump-ore. Generally compact; also cellular and bombshell, the walls of the bomb lined with fibrous, botryoidal iron ore. Color, light and dark brown. Considerable adhering yellowish-white clay.

609. *Bloomfield* mines, about 3 miles south of Roaring Springs. Wash-ore. Specimens consist of a mixture of small masses of brown hematite iron ore, with a considerable amount of argillaceous iron ore, ferruginous clay, and quartz pebbles.

f

	No. 708.	Percentages.
	Per cent.	
Sesquioxide of iron	75.071	= 52.550 per cent. iron.
Binoxide of manganese	3.760	= 3.004 per cent. manganese.
Protoxide of manganese	0.779	
Sesquioxide of cobalt	0.030	
Alumina	2.678	
Lime	0.240	
Magnesia	0.235	
Sulphuric acid	0.182	= 0.073 per cent. sulphur.
Phosphoric acid	0.071	= 0.031 per cent. phosphorus.
Water	13.330	
Insoluble residue	3.948	
Total	100.324	

708. *Bloomfield* mines, about 3 miles south from Roaring Springs. Bombshell-ore. Bombshell-ore, the walls of the shell lined with nodular lumps, consisting mainly of oxide of manganese. The ore is generally fibrous and brittle; also partially foliated, with irridescent surface. a

	No. 709a.	No. 709b.
	Per cent.	*Per cent.*
Iron	22.700	40.250
Manganese	37.611	11.870
Sulphur	0.018	0.015
Phosphorus	0.043	0.033
Alumina	1.144	1.950
Lime	0.470	0.157
Magnesia	0.271	0.216
Silica	2.850	11.360

b

709*a*. *Bloomfield* mines, about 3 miles south of Roaring Springs. Manganese ore. Hard and tough; minutely crystalline; steel gray.
709*b*. *Bloomfield* mines. Manganese ore. Analysed for Pennsylvania Steel Company in 1874, and published by permission.

Analyses of Bloomfield wash-ore made for Pennsylvania Steel Company, and published by permission.

Date of analysis.	Iron.	Phosphorus.
	Per cent.	*Per cent.*
July, 1873	32.25	0.053
March, 1874	39.06	0.041
April, 1874	33.50	0.039
April, 1874	35.00	0.059
May, 1874	36.60	0.053
Average	35.28	0.049

c

Bedford county.—The principal ore of this county is the fossil ore of Formation V; but some deposits of limonite of Formation II exist, though none were worked in the census year. The character of the ore is shown by the following analyses from Report MM, p. 206:

d

	No. 613.	No. 605.
	Per cent.	*Per cent.*
Sesquioxide of iron	56.214	80.000
Sesquioxide of manganese	0.073	0.207
Sesquioxide of cobalt	None.	Trace.
Alumina	4.855	3.069
Lime	0.015	0.310
Magnesia	0.335	0.562
Sulphuric acid	0.012	0.082
Phosphoric acid	0.451	0.201
Water	10.390	12.106
Insoluble residue	27.960	3.970
Total	100.305	100.507
Metallic iron	39.350	56.000
Metallic manganese	0.050	0.144
Sulphur	0.005	0.033
Phosphorus	0.197	0.088

e

613. *Baker's* mine, 1 mile south from Bloomfield furnace. Cambria Iron Company. Brittle, sandy, argillaceous; generally compact; dark brown and liver-brown.

605. *R. Hoover's* mine, 1 mile north from Woodberry. Surface pipe-ore. Stalactitic, brittle, dark-brown. Considerable yellow clay in cells. f

LIMONITE ORES IN THE HUDSON-RIVER SLATES (FORMATION No. III).

In the preface to Report M³, Mr. McCreath thus refers to these ores: "There are found near Mercersburg, and at other localities in Franklin county, important deposits of *bog-ore*, which are now being quite extensively worked, From 1876 to 1880 nearly 10,000 tons of this ore were mined, nearly 4,000 tons of it during 1880. The ore is generally found in the slates of Formation No. III, and has evidently resulted from the decomposition of iron pyrites.

a the large percentage of sulphuric acid which they invariably contain going to confirm this view. They are characterized by an almost uniformly *low percentage of phosphorus*, and by being practically free from manganese."

The following analyses are from Report M³, pp. 1 and 3:

b

Franklin county,	No. 2.	No. 9.	No. 10.	No. 11.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	0.337	0.176	0.192	0.128
Sesquioxide of iron	57.554	50.090	58.142	50.928
Sesquioxide of manganese	Trace.	Trace.	Trace.	Trace.
Sesquioxide of cobalt	Trace.	Trace.	Trace.	Trace.
Alumina	2.100	5.790	3.649	5.520
Lime	0.120	0.300	0.720	0.640
Magnesia	0.115	0.342	0.371	0.421
Sulphuric acid	0.925	0.872	0.742	0.887
Phosphoric acid	0.082	0.105	0.084	0.199
Water and organic matter	14.518	13.896	15.378	14.680
Silicious matter	24.530	27.840	20.030	26.720
Total	100.281	99.411	99.308	100.123
Metallic iron	40.550	35.200	40.850	35.750
Metallic manganese	Trace.	Trace.	Trace.	Trace.
Sulphur	0.370	0.349	0.297	0.355
Phosphorus	0.036	0.046	0.037	0.087
Phosphorus in 100 parts iron	0.088	0.130	0.090	0.243

c

2. *Richmond* furnace bog-bank, about 1 mile northwest of furnace. Bog-ore of III. Sample consisted of 79 pieces taken from ore-pit at different places.

9. *Leib* bank (J. S. Whitmer & Co.), 2 miles east of Mercersburg. Bog-ore in III. Sample consisted of 94 pieces taken from ore-pile.

10. *Jacob Stouffer's* bank, 1 mile east of Mercersburg, Montgomery township. Bog-ore in III. Sample consisted of 129 pieces taken from ore-pit at different places.

11. *R. P. McFarland's* bank, 1½ mile east of Mercersburg, Peters township. Bog-ore in III.

LIMONITE ORES OF THE MEDINA FORMATION.

d

Regarding these ores Mr. McCreath says, in Report MM, p. 198:

Some of the sandstones of the Medina are highly ferruginous, and blocks coated with a crust of limonite sometimes line the crest of the mountains of IV. Local deposits of a coarse limonite are sometimes found along the outcrop, but are never of much value.

West of Orbisonia, in Huntingdon county, a large deposit of limonite fills a cross fissure in the top of the Black Log mountain. (See F, p. 257.)

e

Huntingdon county.	No. 94.	No. 93.	No. 97.
	Per cent.	*Per cent.*	*Per cent.*
Iron	35.500	40.700	44.700
Manganese	3.566	2.269	.....
Sulphur	None.	None.	0.031
Phosphorus	0.478	0.709	0.197
Insoluble residue	29.575	18.100	18.820

94. Iron ore found scattered upon the terrace of the northwest side of Black Log mountain, 1 mile southwest from Beaver gap, and 7 miles from Fort Littleton. (See F, p. 239.) Compact, brittle, sandy; dark brown and reddish brown.

93. Same ore, from the surface on Alexander Ramsey's property, 4 miles northeast from Fort Littleton. (See F, p. 139.) Hard, arenaceous, somewhat cellular; color, various shades of light and dark brown.

97. *William Stambach's* ore-opening, 5 miles northeast from Fort Littleton, on the northwest side of Black Log mountain. (See F, p. 128.) Cellular; the cells for the most part filled with yellow clay; brittle, and of a light-brown color. (D. McCreath.)

f

LIMONITE ORES OF THE LOWER HELDERBERG AND ORISKANY FORMATIONS.

The following notes and analyses of these ores are from Report MM, pp. 196 to 198, and Report M³, pp. 33 and 34:

Accumulations of limonite, quite local and usually insignificant, but sometimes, as at Blair's and Baker's mines in Blair county, of vast width and depth, occur along the many outcrops of the Oriskany sandstone and Lewistown limestone in middle Pennsylvania. For a description of some of these, see Report F, 1878, and Report T, 1879.

713. *Baker's* ore-bank, at Blair furnace, near Altoona. Pipe-ore. Formation No. VI. Brittle, dark-brown pipe-ore; somewhat coated with a yellow clay; pipes very distinct.

728. *Baker's* ore bank, at Blair furnace, near Altoona. Pipe-ore. Brittle, dark-brown pipe-ore; pipes somewhat obliterated.

729. *Baker's* ore-bank, at Blair furnace, near Altoona. Limonite, cellular, brittle, dark brown.

Blair county.	No. 713.	No. 728.	No. 729.	No. 714.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	83.071	83.000	68.286	67.214
Sesquioxide of manganese	0.350	0.312	1.405	0.985
Sesquioxide of cobalt	Trace.	Trace.	0.116	0.102
Alumina	2.124	1.980	3.534	4.440
Lime	0.215	0.210	0.220	0.290
Magnesia	0.312	0.302	0.456	0.479
Sulphuric acid	0.115	0.127	0.257	0.282
Phosphoric acid	0.455	0.673	0.600	0.506
Water	11.772	12.314	11.950	9.660
Insoluble residue	1.675	1.430	13.630	16.120
Total	100.089	100.348	100.454	100.078
Metallic iron	58.150	58.100	47.800	47.050
Metallic manganese	0.244	0.217	0.978	0.685
Sulphur	0.046	0.051	0.103	0.113
Phosphorus	0.199	0.294	0.262	0.221

714. *Baker's* ore-bank, at Blair furnace, near Altoona. Bombshell-ore. Hard, tough, arenaceous; dark brown and liver-brown. The walls of the bombs are coated with a sandy clay of a pinkish-gray color.

Perry county.	No. 108.
	Per cent.
Sesquioxide of iron	60.928
Sesquioxide of manganese	0.100
Alumina	*a* 3.746
Lime	0.660
Magnesia	0.216
Sulphuric acid	0.155
Phosphoric acid	0.185
Water and organic matter	9.390
Silicious matter	24.620
Total	100.000
Metallic iron	42.650
Metallic manganese	0.070
Sulphur	0.062
Phosphorus	0.081
Phosphorus in 100 parts iron	0.189

a By difference.

108. *Rinesmith's* mine, 1 mile southwest of Rinesmith's farm, in Sandy Hollow, northeast of Gibson rock. Brown hematite of VII. Hard and compact; some portions of sample shaly; irridescent; carries some adhering yellow clay; various shades of brown. (J. M. S.)

LIMONITE ORES OF THE DEVONIAN—CHIEFLY OF THE MARCELLUS FORMATION.

A continuous outcrop of more or less ferriferous calcareous clay-bed runs through the middle counties of Pennsylvania, carrying, on Yellow creek, in Blair county, on Aughwick creek, in Huntingdon county, and on the affluents of the Juniata river, in Juniata and Perry counties, large deposits of brown hematite, the full width of the bed, which sometimes amount even to 20 or 25 feet. Slopes are sunk on the bed to depths of 100 or 200 feet in the ore, when nuts and masses of rough carbonate replace the limonite, and, finally, further down, the whole bed turns to a dark pyritous clay. For descriptions, see Report of Progress F.—(Report MM, p. 193.)

Perry county.—In this county 12,734 tons of limonite were mined in the census year, the greater part, if not the whole, of which came from the Marcellus ore-bed, "which underlies the black slates of No. VIII, and overlies the green calcareous shales. Although the thickness of the ore-deposit is extremely variable, yet a large quantity of ore has been mined at different localities from this horizon. The quality is usually quite good, the ore being almost uniformly low in its contents of phosphorus. A small quantity of ore has also been mined in the *Corniferous shales;* but the quality of the ore is usually inferior, although occasional deposits are met with which are quite rich in iron" (Report M³, pp. 29 and 30). The following notes and analyses are from Report M³, pp. 32 and 33:

100. *Washer* ore-pit, about 2 miles southwest from Newport, on Limestone ridge. From the clay in the ore-pit near the surface. Corniferous brown hematite. Generally compact and fine-grained; appearance, shaly; color, reddish brown.

101. *Washer* ore-pit, about 2 miles southwest from Newport, on crest of Limestone ridge, at Newport and Duncannon road. In synclinal of Oriskany sandstone, in the upper part of the Corniferous shale. Corniferous brown hematite. Compact and fine-grained; dark brown and reddish brown; some of the ore has a shaly appearance.

a

	No. 100.	No. 101.	No. 102.	No. 103.	No. 104.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	50.285	61.143	62.000	59.500	54.214
Sesquioxide of manganese	0.051	0.072	0.072	0.120	0.083
Alumina	*a* 5.101	2.937	4.191	*a* 5.072	2.044
Lime	1.070	0.650	0.600	0.720	0.600
Magnesia	0.342	0.288	0.324	0.324	0.327
Sulphuric acid	Trace.	0.107	0.135	0.100	0.047
Phosphoric acid	0.146	0.176	0.279	0.469	2.072
Water and organic matter	7.465	9.980	9.925	10.495	8.065
Silicious matter	35.540	24.640	22.570	23.200	31.870
Total	100.000	99.993	100.096	100.000	99.332
Metallic iron	35.200	42.800	43.400	41.650	37.950
Metallic manganese	0.035	0.050	0.050	0.083	0.058
Sulphur	Trace.	0.043	0.054	0.040	0.019
Phosphorus	0.064	0.077	0.122	0.205	0.905
Phosphorus in 100 parts iron	0.181	0.179	0.281	0.492	2.384

a By difference.

102. *Washer* ore-pit, about 2 miles southwest from Newport, on crest of Limestone ridge. Corniferous brown hematite. Appearance, sandy; very brittle; dark brown and yellowish brown.

c 103. *Limestone Ridge Mining Company*, 2 miles from Newport, on Limestone ridge; east end of long ore-pit, east of Washer ore-pit. Corniferous brown hematite. Bombshell-ore, with considerable clay in bomb; very brittle; color dark brown.

104. *Limestone Ridge Mining Company;* from first opening northeast of east ore-pit; on crest of Limestone ridge, south of Newport; on the road leading off from the Newport and Bailey Station road. In the synclinal of the Oriskany sandstone. A few hundred tons mined by the Limestone Ridge Mining Company. Corniferous brown hematite. Generally compact and fine-grained; somewhat shaly; dark brown.

Juniata county.—All the ore mined in this county in the census year was reported to be fossil-ore. The Devonian limonite exists, but it was apparently not worked.

Mifflin county.—This county produced 24,366 tons of limonite in the census year, which presumably was all mined from the Devonian. The following notes and analyses are from Report M, p. 64:

d

	II.
	Per cent.
Iron	42.500
Sulphur	0.044
Phosphorus	0.078
Insoluble residue	23.890

II. *McVeytown Gap*, Ross ore-opening. Ore from upper opening. Limonite, compact, argillaceous; of a light-brown color.

Huntingdon county.—The following notes and analyses are from Report M, pp. 66 to 68; Report MM, p. 194; Report M³, p. 40:

e

	XV.	XVI.	XVII.	XVIII.	XIX.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	47.500	47.500	47.300	45.000	51.700
Sulphur	Trace.	0.013	Trace.	0.032	0.023
Phosphorus	0.402	0.111	0.491	0.187	0.068
Insoluble residue	17.260	14.100	17.900	26.580	10.490

XV. *Lane* ore-bank, Hill valley, 5 miles northwest from Orbisonia. Ore in Oriskany sandstone, lower portion Chestnut ridge. Lane property. Limonite, sandy, with large admixture of ochreous earth.

XVI. *Hick's* ore-bank, between Logan ore-bank and Stewart's ore, 5 miles from Orbisonia, Chestnut ridge. Rockhill Coal and Iron Company. Limonite, cellular, cells for the most part filled with ochreous ore.

f XVII. *Douglas* ore-bank, opposite Lane ore-bank, 5 miles northwest from Orbisonia. Limonite, compact, silicious and cellular.

XVIII. *Mountain* ore-bank, 4 miles southwest from Orbisonia, in crevice of Medina sandstone, Blacklog mountain. Rockhill Coal and Iron Company. Limonite, compact, botryoidal, somewhat cellular; color, various shades of brown.

XIX. *Sandy Ridge* ore, 2 miles north from Orbisonia. Rockhill Coal and Iron Company. Limonite, very hard and compact, containing considerable ochreous iron ore; dark-brown color.

	No. 563.	No. 125.	No. 126.
	Per cent.	*Per cent.*	*Per cent.*
Protoxide of iron	25.714	.....	.....
Sesquioxide of iron	27.000	53.857	66.571
Bisulphide of iron	0.429	.....	.....
Sesquioxide of manganese	0.289	0.275	0.510
Sesquioxide of cobalt	0.580	.....	.....
Alumina	2.002	*a* 2.861	*a* 1.606
Lime	1.143	0.690	0.710
Magnesia	0.832	0.313	0.285
Sulphuric acid	0.502	0.190	0.075
Phosphoric acid	0.137	0.114	0.323
Carbonic acid	15.938	.....	.....
Carbonaceous matter	2.681	.....	.....
Water	6.460	.....	.....
Water and organic matter	.....	13.200	13.580
Silicious matter	.....	28.500	16.340
Insoluble residue	16.211	.....	.....
Total	99.918	100.000	100.000
Metallic iron	39.100	37.700	46.600
Metallic manganese	0.201	0.191	0.355
Sulphur	0.430	0.076	0.030
Phosphorus	0.060	0.050	0.141
Phosphorus in 100 parts iron	.....	0.132	0.302

a By difference.

563. *McCarthy's* ore-bank, near Saltillo. Marcellus iron ore. See F, p. 237. Altered carbonate ore; generally compact, with laminated structure. Color, various shades of brown.

125. Property of Dr. J. A. Shade, 2 miles southwest from Shade gap, Shade valley. Outcrop of Marcellus ore-bed. Brittle; cellular; full of seams of ochreous iron ore; color, generally light brown. Ore carries a large amount of carbonaceous matter.

126. Property of Isaac Taylor, 3 miles southwest from Shade gap. Marcellus ore-bed. Cellular; brittle; light and dark brown; ore carries considerable carbonaceous matter.

Fulton county.—The following analysis is from Report M³, p. 42:

	No. 132.
	Per cent.
Sesquioxide of iron	66.428
Sesquioxide of manganese	0.132
Alumina	*a* 2.024
Lime	0.720
Magnesia	0.270
Sulphuric acid	0.170
Phosphoric acid	0.121
Water and organic matter	11.315
Silicious matter	18.820
Total	100.000
Metallic iron	46.500
Metallic manganese	0.092
Sulphur	0.068
Phosphorus	0.053
Phosphorus in 100 parts iron	0.113

a By difference.

132. From the land of P. Awl & Brother, on the northwest side of Sidney Knob, three-fourths of a mile northwest of Burnt Cabins. Marcellus brown hematite. Generally fine-grained and compact; hard and brittle; color various shades of dark brown and reddish brown.

a *Franklin county.*—The following analysis is from Report M³, p. 1:

	No. 1.		No. 1.
	Per cent.		*Per cent.*
Protoxide of iron	None.	Water and organic matter	11.754
Sesquioxide of iron	67.142	Silicious matter	17.280
Sesquioxide of manganese	0.589	Total	100.389
Sesquioxide of cobalt	0.390		
Alumina	1.998	Metallic iron	47.000
Lime	0.500	Metallic manganese	0.410
b Magnesia	0.252	Sulphur	0.116
Sulphuric acid	0.290	Phosphorus	0.085
Phosphoric acid	0.194	Phosphorus in 100 parts iron	0.180

1. *Bower's Furnace* ore-bank, on Mrs. Eliza Furray's farm, 9 miles southwest of Mercersburg, Warren township. Brown hematite of VIII.

LIMONITE ORES OF THE MAUCH CHUNK RED SHALE.

The following note is from Report MM, p. 192:

These ores are merely the decomposed outcrops of beds of carbonate ore underlying the conglomerate. Only one specimen has thus far been analyzed.

c

Huntingdon county.	No. 949.
	Per cent.
Iron	25.240
Sulphur	0.029
Phosphorus	0.100
Insoluble residue	48.240

949. *Jos. Diggin's* ore-opening, 1¾ mile east of Broad Top City. Hard, botryoidal; yellowish brown to dark brown. (S. S. Hartranft.)

IV. CARBONATE ORES.

d

The limonite ores of the Coal Measures occur along the outcrops of limestone-beds, and are, in general, simply the weathered outcrops of seams of carbonate ore. In classifying the output of iron ore in the census year, it was found impossible to separate the altered from the unaltered ores of the Coal Measures, and they will be referred to in these notes under the comprehensive heading of *Carbonate Ores of the Coal Measures and their Derivatives.* The older carbonate ores will, however, be first considered.

CARBONATE ORES OF THE SILURO-CAMBRIAN FORMATION.

The following, in regard to these ores, is from Report MM, pp. 187 and 188:

One theory of the origin of the limonites of our limestone valley derives them from intercalated beds of carbonate of iron and lime; e and this view is supported by the frequent presence of rough carbonate of iron below or back of outcrop deposits of limonite in the beds of the Hamilton No. VIII, limiting the practical working of the limonite to a certain depth beyond which it does not exist.

Such carbonates have been found in the limestones of No. II, on the surface of which such vast accumulations of limonite exist, as at Ironton, Trexlerville, Moselem, Pine Grove, Mount Alto, Pennsylvania furnace, Springfield, Bloomfield, etc.

Northampton county.	No. 995.	Percentages.
	Per cent.	
Protoxide of iron	54.385	= 43.050 per cent iron.
Sesquioxide of iron	1.071	
Protoxide of manganese	3.254	= 2.521 per cent. manganese.
Protoxide of cobalt	0.010	
f Alumina	1.457	
Lime	0.540	
Magnesia	0.540	
Sulphuric acid	0.112	= 0.045 per cent. sulphur.
Phosphoric acid	0.263	= 0.115 per cent. phosphorus.
Carbonic acid	35.340	
Water (by difference)	0.923	
Insoluble residue	2.105	
Total	100.000	

995. *Saucon Iron Company's Wharton* mine, 2 miles east of Hellertown, Northampton county. Carbonate ore from shaft 126 feet deep. See analysis of limonite from this mine, § 13, No. 967. Fine-grained; hard and tough; fracture, conchoidal, inclining to rough; color, teel-gray on fresh surface.

CARBONATE ORES OF THE MARCELLUS FORMATION.

It is from these ores that the limonites of this formation are derived; on sinking through a seam of limonite **a** the carbonate is invariably encountered. The following notes and analyses are from Report M, pp. 70 and 71, and Report M³, pp. 31 and 39:

Mifflin county.	I.	II.
	Per cent.	*Per cent.*
Iron	33.500	42.500
Sulphur	0.734	0.260
Phosphorus	0.110	0.135
Insoluble residue	18.870	3.390

b

I. *Ross* ore-bank, McVeytown gap, 1 mile north of McVeytown. Black carbonate ore; lower depths of vein. Here this specimen alternates with shale, and, including the yellow hematite, measures from 24 to 28 feet. Carbonate ore, exceedingly hard and compact, surface somewhat hematitic and botryoidal, structure laminated, and fracture conchoidal; color, various shades of black. The ore carries considerable carbonaceous matter.

II. *Ross* ore-bank, McVeytown gap, 1 mile north from McVeytown. Carbonate ore; upper portion in layers divided by black shale. Whole thickness of measures, including alternations, 24 to 28 feet. Carbonate ore, hard and compact; color, bluish black; crust, hematitic; fracture, conchoidal, showing small crystals of pyrites. Ore carries considerable carbonaceous matter, and when thoroughly roasted yields 60 per cent. metallic iron and 5 per cent. insoluble silicious residue.

c

Mifflin county.	III.
	Per cent.
Protoxide of iron	48.857
Sesquioxide of iron	0.825
Bisulphide of iron	0.262
Alumina	2.240
Protoxide of manganese	1.625
Lime	4.536
Magnesia	0.569
Phosphoric acid	1.314
Sulphuric acid	0.133
Carbonic acid	32.650
Water	0.368
Organic matter	0.360
Insoluble residue	6.410
Total	100.149
Iron	38.700
Sulphur	0.192
Phosphorus	0.574

d

III. *Lewistown* section, 1 mile northwest of Lewistown. Carbonate ore, taken from near the surface. Clay iron ore; steel-gray color; hard and compact, with conchoidal fracture.

e

Mifflin county.	No. 124.
	Per cent.
Metallic iron	28.325
Sulphur	0.306
Phosphorus	0.036
Silicious matter	30.170
Phosphorus in 100 parts iron	0.127

124. *Robert McCormick's* ore-opening, in Oliver township, 4 miles southwest from McVeytown. Carbonate ore of VIII(?). Soft; fine-grained; argillaceous; pearl-gray color.

CARBONATE ORES OF THE POCONO (?) FORMATION.

f

In *Sullivan county*, near Ganoga lake (Long pond), deposits of carbonate ore of uncertain age have been found; they do not appear to be of much commercial importance. No iron ore was mined in Sullivan county in the census year.

a

CARBONATE ORES OF THE MAUCH CHUNK RED SHALE FORMATION.

The following notes and analyses are from Report MM, pp. 184 to 187, and Report M³, p. 46:

Everywhere throughout Pennsylvania, where the great Conglomerate exists, one or more plates of carbonate ore exist in the shales beneath it. Sometimes the shales are merely studded with balls of ore. In many places local lenticular deposits of solid grayish-blue carbonate extend for hundreds of yards, or a mile or more, with a maximum thickness of 3 or 4 feet, as on the Tangascootac and Queen's run, in Clinton county. At Ralston, in Lycoming county, there are several beds, which have been extensively stripped for long distances under the conglomerate escarpment at the summit of the mountain walls of Lycoming creek. Around the Tioga mountain the bed is 1 foot thick. In the gaps of the Conemaugh, Loyalhanna, and the Youghiogheny rivers, in Westmoreland and Fayette counties, the ore appears, and has been worked in certain places. It spreads in patches over the back of Laurel Hill, in Somerset county, and is seen in many places along the front of the Allegheny mountain, and around Broad Top mountain, in Huntington and Blair counties.

b Sometimes the beds have been decomposed into brown hematite for a certain distance back from the outcrop. Bogs of loose limonite have formed on the terraces in front of the outcrop, some of them many acres in extent, and a few of them removed for use in furnaces.

The best description of this extensive deposit is to be found in Professor Stevenson's Report KK (see Index to KK, p. 422), where the ores are described under the names Big and Little Honeycomb, Kidney, Big Bottom of XI, and Red Belt of XI.

The analyses given under this section show the ores to be of excellent quality, generally very rich in iron, and containing only a comparatively small amount of phosphorus.

Fayette county.	No. 56.	No. 55.	No. 551.	No. 550.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	41.000	31.200	41.400	36.200
Sulphur	0.191	0.253	0.184	0.107
Phosphorus	0.120	0.129	0.151	0.154
Insoluble residue	6.810	21.930	6.430	12.980

c

56. *Vernon* mines, near old Mount Vernon furnace, Bullskin township. Pin-vein ore. (See KK, p. 128.) Compact, fine-grained, brittle, bluish-gray; shows small specks of pyrite.

55. *Vernon* mines, near old Mount Vernon furnace, Bullskin township. Lower big-bottom ore. (See KK, pp. 129, 131.) Structure somewhat flaggy; brittle; dark bluish gray.

551. *Lemont Furnace* mines, northeast from Uniontown, North Union township. Big honeycomb ore. (See KK, p. 127.) Cellular; exceedingly brittle; spotted with pyrites; generally bluish gray. (D. McCreath.)

550. *Lemont Furnace* mines, northeast from Uniontown, North Union township. Lower big-bottom ore. (See KK, p. 131.) Brittle, rather coarse-grained; bluish gray. (D. McCreath.)

d

Fayette county.	No. 549.	Percentages.
	Per cent.	
Protoxide of iron	49.885	= 38.800 per cent. iron.
Protoxide of manganese	0.799	= 0.619 per cent. manganese.
Alumina	1.092	
Lime	1.240	
Magnesia	1.203	
Sulphuric acid	1.020	= 0.408 per cent. sulphur.
Phosphoric acid	0.440	= 0.195 per cent. phosphorus.
Carbonic acid	31.294	
Water	1.575	
Carbonaceous matter	0.680	
Insoluble residue	10.605	
Total	99.833	

e

549. *Lemont Furnace* mines, northeast of Uniontown, North Union township. Kidney-ore. (KK, p. 129.) Fine-grained; hard and tough; fracture, conchoidal; color, generally bluish gray. (D. McCreath.)

Fayette county.	No. 730.	No. 740.	No. 731.
	Per cent.	*Per cent.*	*Per cent.*
Iron	42.300	42.500	42.500
Sulphur	0.227	0.484	0.153
Phosphorus	0.128	0.160	0.130
Insoluble residue	9.640	5.190	7.110

f

730. *Center Furnace* mines, Wharton township. Big honeycomb ore. (See Report KKK, pp. 218, 219, 220.) More or less oxidized throughout; color, light brown and bluish gray; fracture, irregular, rough. Shows numerous small drussy cavities.

740. *Center Furnace* mines, Wharton township. Little honeycomb ore. (See KKK, p. 218.) Crust hematitic; spotted with pyrites; hard and tough. Fracture, conchoidal; color, generally bluish gray on fresh surface.

731. *Center Furnace* mines, Wharton township. Little honeycomb ore (?). Crust hematitic; irregularly seamed with calcareous matter; brittle; bluish gray on fresh surface; fracture, conchoidal.

CARBONATE ORES OF THE POTTSVILLE CONGLOMERATE. a

The following notes and analyses are from Report MM, p. 183:

The ores of this horizon are best described in Professor Stevenson's Report KK, under the head of the Mount Savage ore-group (see index to KK, pp. 421, 422), because the beds have been extensively mined in southern Fayette county, under the names Stratford ore (KK, pp. 110, 124, 196), Carr's ore (p. 140), Jude ore (p. 124), and Mahan ore (pp. 124, 160).

In the upper part of the conglomerate No. XII occur abundant deposits of ore-balls and lens-shaped plates along Shade creek, near Old Shade furnace, in Somerset county. (See HHH, p. 147.)

Ore of the same horizon occurs about one-quarter of a mile east of Listonville, in southern Somerset county. (See HHH, p. 271.)

In the conglomerate along the Beaver waters ore is often found. (Q, pp. 225 and 69.)

In many other counties of western Pennsylvania carbonate ball-ore has been noticed at this horizon, at the base of the Coal Measures, but nowhere in quantity justifying mining operations. b

Lawrence county	No. 759.	No. 760.
	Per cent.	*Per cent.*
Iron	37.250	35.200
Manganese	0.655	0.807
Sulphur	0.154	0.335
Phosphorus	0.145	0.178
Lime	3.020	4.120
Magnesia	1.747	2.223
Insoluble residue	9.790	11.190

c

759. *Neshannock* iron-ore opening, near Neshannock Falls, Wilmington township. From the horizon of the Mercer limestone. Crust hematitic; exceedingly hard and tough, with irregular fracture and reddish-gray color.

760. *New Castle* iron-ore opening, 2 miles north from New Castle, in Neshannock township. From the horizon of the Mercer limestone. Exceedingly hard and tough, with irregular fracture and dark bluish-gray color.

CARBONATE ORES OF THE COAL MEASURES AND THEIR DERIVATIVES.

A.—Of the Lower Productive Coal Measures (Freeport, Kittanning, and Clarion Groups).

The following notes and analyses are from Report MM, pp. 174 to 191; Report M³, pp. 48 to 53:

Over the Freeport upper coal, a calcareous ore occurs locally in Hampton township, Allegheny county. (Q, p. 159.) d

The irregular bed of ore mined at Springfield, in Fayette county, comes directly under the Mahoning sandstone. It thins away to nothing northward; and southward reappears on Decker's creek, in West Virginia. (KK, pp. 121, 122.)

Over the Freeport upper coal, ore in ferruginous shale occurs at Hooversville, and at Lohr's, and elsewhere on Stony creek, Somerset county. (See HHH, p. 121.)

Ore overlying the Freeport upper coal (?) was extensively worked for Ritter furnace, on Black lick, and at Lamoreaux's, in Cambria county. (HH, pp. 161, 163.)

The Freeport upper limestone has large quantities of ore associated with it at Brady's bend, on the Allegheny river, where it has been extensively worked. (HHHH, p. 204; and HHHHH, 1879.)

On the lower waters of Yellow creek, in Indiana county, D. Griffith's bed, 2 feet thick, in two layers 3½ feet apart, lies under one limestone and over another. (See HHHH, p. 205.)

Huge lumps of handsome ball-ore are scattered through the Bolivar fire-clay, under the Freeport upper limestone, between Cucumber and Jonathan's run, Stewart township, Fayette county (KKK, p. 89). And again, 10 feet from the bottom of the 30-foot plastic clay e deposit over the Freeport lower coal-bed, on Tub Mill run, Fairfield township, Westmoreland county, is a persistent stratum of them. (See KKK, p. 160, section Fig. 64, p. 158.)

The Freeport upper limestone has often been mistaken for iron ore along Jacob's creek, in Westmoreland county; and in Tyrone township, of Fayette county, it actually has a top layer of pretty fair ore, 16 to 20 inches thick; 10 inches thick on Dunbar creek; a foot thick at Springfield furnace, changing to limestone. It is known as "coal-bank" ore on Jacob's creek. (See KK, p. 122.) This is the excellent ore of Pridevale and Decker's creek, and Booth's creek, in West Virginia.

In the Freeport upper limestone, some layers are a calcareous iron ore in Big Beaver township, Beaver county. (Q, p. 224.)

Under the Freeport upper limestone, ore occurs on Pine creek, Hampton township, Allegheny county. (Q, p. 161.)

Between the Freeport upper and lower coals is a persistent bed of rich ore, at Pinkerton point, on Castleman's river, Somerset county; and the same (?) appears at Castleman station. (HHH, p. 185.)

Ball-ore occurs over the Freeport lower coal on Black creek, Cambria county, at Big Bend. (Moore's.) (See HH, p. 161.)

On the Freeport lower limestone, ore occurs at various places, and ore-balls everywhere in the Beaver-river district. (Q, pp. 49, 93, 96, 138, 187, 219, 221, 241.) f

Under the Johnstown cement bed, 10 feet thick, in the Conemaugh bluffs, above the mouth of Tom's run, Indiana county, a persistent bed of carbonate, 8 inches thick, has been worked. (See HHHH, pp. 178 and 179, Fig. 44.)

The Johnstown cement bed under the Freeport lower coal is represented at Anderson's bridge, Forward township, Butler county. (Q, pp. 111, 112.)

The Johnstown cement bed ore is probably represented in Fayette county by "the furnace ore" of Jacob's creek. (See KK, p. 123.)

Under the Darlington (Kittanning upper) coal-bed ore-balls are abundant in north Allegheny, south Butler, and north Beaver counties. (Q, pp. 117, 184, 194, 200, 222, 245, 263.)

Shales carrying carbonate ore replace the Kittanning upper limestone on Laurel run, Fayette county. (See KKK, pp. 109, 110.)

Below the Kittanning (?) coal in Fayette county, Springfield township, nests of ore replace the clay. (See KK, p. 140.)

a Above the Kittanning lower coal (C), 10 feet on the Conemaugh at Lockport and Bolivar, occurs a 6-inch (local?) bed of carbonate ore. (See HHHH, p. 65, Fig. 5.)

This horizon is represented on Schlimmer's run, in western Indiana county, by 50 feet of shales, through which ball-ore is disseminated in lumps of all sizes, and a plate of the ore reported under the fire-clay of the Kittanning upper coal (D). (See HHHH, p. 267.)

Over the Clarion coal (B) on Simpson's creek, in Indiana county, ball- and plate-ore occur, but not workable. (See HHHH, p. 191.)

A persistent outcrop of carbonate ore over the Clarion coal, but of unknown value, occurs along Fallen Timber run, Cambria county. (HH, p. 82.)

Between the Clarion and Brookville beds (A and B) occurs the persistent carbonate ore-bed of Hooversville, Somerset county, opened at Clark's, in two bands, 2 feet thick, and with only 0.3 phosphorus. (See HHH, p. 120.)

This is probably the same ore horizon as that at the forks of Paint creek, Somerset county, where at least 2 feet of good carbonate plate- and ball-ore exists at water-level. (See HHH, p. 133, and *Geology of Pennsylvania*, vol. 2, p. 655; 1858.)

Excellent carbonate ore in three layers occurs at Silver diggings, in Well's creek, Somerset county, at some undetermined horizon **b** (low?) in the lower productive Coal Measures. (HHH, p. 18, plate 2.)

Below the Clarion coal, 20 feet, ball-ore is very abundant throughout 6 feet of shale at Lloydsville, Cambria county. (HH, p. 87.)

Immense balls of carbonate ore, in shales, between the Clarion and Brookville coals, occur on Levi run, Cambria county. (HH, pp. 91, 92.)

A lean silicious ore is found between the Clarion and Brookville coals on Moore's hill, on Black creek, Cambria county. (HH, p. 160.)

Over the Brookville coal ball-ore is abundant at New Brighton, Beaver county. (Q, p. 250.)

Armstrong county.—This county produced 31,557 tons of ore in census year. The following notes and analyses are from Report M³, pp. 48 to 52, and Report MM, p. 178:

The principal iron ores of Armstrong county are found at the horizon of the ferriferous limestone. These ores have long been mined and have been the principal source of supply for the blast-furnaces of the county. The ore occurs both as a brown hematite and as a carbonate. The former is usually very rich in iron, averaging, when properly mined, nearly 50 per cent. metallic iron; and as the **c** percentage of phosphorus is not excessive, a very good quality of mill-iron can be made from its use. The average thickness of the ore is only about 8 inches; but as it occurs directly in contact with the ferriferous limestone—which is the flux used in the furnace—it can be easily and profitably mined. The carbonate ore is always roasted before being smelted, and at some of the furnaces it is customary to roast both varieties of the ore. For this purpose the slack coal is generally used. Besides adding by its ash a considerable percentage of silicious matter to the roasted, ore it not unfrequently carries quite a large percentage of phosphorus, which materially affects the quality of the pig-iron produced. This question has already been discussed by Mr. William G. Platt in his report on Armstrong county, volume H⁵, pp. lvii to lxiii, so that no further reference to it is here necessary.

	No. 151.	No. 152.	No. 153.	No. 154.	No. 966.	No. 965.	No. 156.	No. 155.	No. 157.	No. 158.	No. 159.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Protoxide of iron	None.	None.	None.	None.	41.400	46.285	.....	None.	41.464	38.378	42.428
d Sesquioxide of iron	73.143	70.714	73.928	68.928	2.000	1.428	.....	65.928	10.310	2.646	2.233
Sesquioxide of manganese	1.386	2.421	1.344	2.048	.....	.....	.....	1.563	.....	.....	.....
Sesquioxide of cobalt	Trace.	0.010	0.020	Trace.	.....	.....	.....	0.020	.....	.....	.....
Bisulphide of iron	.....	.....	.....	.....	0.041	0.118	.....	.....	0.062	0.090	0.187
Protoxide of manganese	.....	.....	.....	.....	1.896	1.655	.....	.....	2.353	1.153	0.799
Protoxide of cobalt	.....	.....	.....	.....	.....	.....	.....	.....	Trace.	Trace.	0.010
Oxide of cobalt	.....	.....	.....	.....	Trace.	Trace.	.....	.....	.....	.....	.....
Alumina	1.691	1.491	1.532	1.358	1.184	0.823	14.328	2.688	1.949	1.223	0.916
Lime	4.920	7.630	1.610	8.670	8.920	7.080	6.030	7.710	4.690	10.840	7.150
Magnesia	0.800	0.547	0.501	0.576	1.801	1.484	0.691	0.901	2.054	2.663	1.881
Silica	.....	.....	.....	.....	.....	.....	31.800	.....	.....	.....	.....
Sulphuric acid	0.010	0.010	Trace.	0.012	Trace.	Trace.	.....	0.580	Trace.	Trace.	0.030
Phosphoric acid	0.636	0.705	0.740	0.584	0.346	0.600	.....	1.074	0.623	0.480	0.334
e Carbonic acid	3.980	5.230	None.	6.980	34.208	35.358	.....	} 5.365	} 31.450	32.074	32.622
Water	8.800	7.465	12.615	6.600	.....	.....	.....		} 1.315	1.910	1.959
Silicious matter	4.800	3.860	8.060	4.370	.....	.....	.....	14.520	3.760	8.540	9.460
Insoluble residue	.....	.....	.....	.....	6.430	3.150	.....	.....	.....	.....	.....
Water and carbonaceous matter	.....	.....	.....	.....	1.774	2.019	.....	.....	.....	.....	.....
Total	100.166	100.143	100.350	100.126	100.000	100.000	.....	100.349	100.000	100.000	100.000
Metallic iron	51.200	49.500	51.750	48.250	33.620	37.050	24.600	46.150	39.500	31.750	34.650
Metallic manganese	0.965	1.686	0.936	1.426	1.469	1.282	1.232	1.088	1.823	0.893	0.619
Sulphur	0.004	0.004	Trace.	0.005	0.022	0.063	0.528	0.232	0.029	0.042	0.112
Phosphorus	0.278	0.334	0.323	0.255	0.151	0.262	0.544	0.469	0.272	0.224	0.146
Phosphorus in 100 parts iron	0.542	0.674	0.624	0.528	.....	.....	2.211	1.016	0.688	0.705	0.421

f

151. At *Stewardson* furnace, 1 mile east from mouth of Mahoning creek, in Madison township. F. B. & A. Laughlin. Ferriferous limestone ore. [Limonite.] Very compact and fine-grained; exceedingly brittle, with rough irregular fracture. Irregularly seamed with calcite. Numerous pits filled with white pulverulent silicate of alumina. Reddish brown.

152. At *Stewardson* furnace, 1 mile east from mouth of Mahoning creek, in Madison township. F. B. & A. Laughlin. Ferriferous limestone ore. "Red ore." [Limonite.] Very compact and fine-grained; exceedingly brittle, with rough irregular fracture. Irregularly seamed with calicite. Generally reddish brown.

153. At *Stewardson* furnace, 1 mile east from mouth of Mahoning creek, in Madison township. F. B. & A. Laughlin. Ferriferous limestone ore. "Brown ore." [Carbonate.] Cellular, also fine-grained; dark brown and yellowish brown.

154. *Campbell & Barrett*, 1 mile northwest of Centreville, Madison township. Ferriferous limestone ore. [Carbonate.] Exceedingly compact and fine-grained; hard and tough, with rough, irregular fracture; somewhat conchoidal; numerous pits of pulverulent silicate of alumina. Reddish brown. a

966. *Brown & Musgrove's* ore-opening, at Slabtown, on north fork of Pine creek, 4 miles southeast of Templeton. Buhrstone iron ore. Somewhat oxidized; fine-grained. Color bluish gray to reddish brown; fracture irregular.

965. *Pine Creek Furnace* ore opening, 6 miles northeast of Kittanning. Buhrstone iron ore. Somewhat oxidized; fine-grained. Color, bluish gray to reddish brown; fracture irregular, rough.

156. *Stewardson* furnace, 1 mile east of mouth of Mahoning creek, in Madison township. F. B. & A. Laughlin. Ore-screenings. [Limonite.]

155. *Stewardson* furnace, 1 mile east from mouth of Mahoning creek, in Madison township. F. B. & A. Laughlin. Ferriferous limestone ore. "Mixed ores roasted."

157. *J. A. Colwell*, one-half mile northwest of Mahoning furnace, in Madison township. Ferriferous limestone ore. [Carbonate.] Rather coarse-grained and porous; more or less oxidized throughout; mottled with calcite; color generally reddish gray. b

158. *Brady's Bend Iron Company*, in Brady's Bend township, 1 mile southwest of Brady's bend. Ore from Phillip's hill. Ferriferous limestone ore. Crust hematitic; exceedingly hard and tough; rather fine-grained; fracture irregular, rough; color, reddish gray.

159. *Stewardson* furnace, 1 mile east from mouth of Mahoning creek, in Madison township. F. B. &. A. Laughlin. Blue carbonate ore. Rather hard and tough; coarse-grained; bluish gray.

Butler county.—Product in census year, 2,318 tons. The following notes and analysis are from Report M³, p. 54:

	No. 566.	Percentages.
	Per cent.	
Protoxide of iron	34.200	=34.50 per cent. of iron.
Sesquioxide of iron	11.285	
Alumina	4.326	
Lime	4.720	
Magnesia	2.854	
Sulphuric acid	0.120	=0.048 per cent. sulphur.
Phosphoric acid	0.849	=0.371 per cent. phosphorus.
Carbonic acid	28.670	
Water	2.500	
Insoluble residue	10.765	
Total	100.289	

c

556. Iron-ore opening near Denny's mill, 1½ mile west from Old Winfield furnace, Winfield township. Ore 60 to 70 feet below the Freeport Upper coal. (See Report Q, p. 92.) Carbonate ore, considerably oxidized; reddish brown. (D. McCreath.) d

Clarion county.—In the census year 15,705 tons of Coal-Measures ore were mined in this county. The following analyses are from Report M³, pp. 52 and 53:

	No. 161.	No. 162.	No. 163.
	Per cent.	*Per cent.*	*Per cent.*
Bisulphide of iron	0.109	0.491	0.009
Protoxide of iron	44.357	48.535	38.571
Sesquioxide of iron	2.857	1.101	2.142
Protoxide of manganese	2.101	1.282	1.756
Protoxide of cobalt	Trace.	Trace.	Trace.
Alumina	0.743	0.528	1.027
Lime	6.380	5.650	6.750
Magnesia	2.248	2.396	1.992
Sulphuric acid	Trace.	Trace.	Trace.
Phosphoric acid	0.643	0.277	2.333
Carbonic acid	33.333	36.109	29.403
Water	1.789	0.711	2.137
Silicious matter	5.440	2.920	13.880
Total	100.000	100.000	100.000
Metallic iron	36.550	38.750	31.500
Metallic manganese	1.628	0.994	1.361
Sulphur	0.058	0.262	0.005
Phosphorus	0.281	0.121	1.019
Phosphorus in 100 parts iron	0.768	0.312	3.234

e

f

161. *Sligo Furnace* bank, Piney township. Ferriferous limestone ore. [Carbonate.] Specimen more or less oxidized; calc-spar in thin plates; somewhat cellular; bluish gray and reddish gray.

162. *Fox* farm, Piney township. Ferriferous limestone ore. Plate-ore. [Carbonate.] Very fine-grained; full of little pits partially filled with calc-spar; rather hard and tough; bluish gray.

163. *Hindman's* quarry, Clarion township. Ferriferous limestone ore. Ore occurs in balls. [Carbonate.] Hard and tough; rather coarse-grained; surface somewhat oxidized; bluish gray.

a *Fayette county.*—This county produced 76,140 tons of ore in the census year. This was chiefly mined near the horizon of the Pittsburgh coal-seam. The following analyses of ore from the Lower Productive Measures are from Report MM, p. 180:

	No. 741.	No. 738.
	Per cent.	*Per cent.*
Iron	33.900	38.100
Sulphur	0.333	0.159
Phosphorus	0.302	0.115
Insoluble residue	18.690	9.250

b 741. *Fayette* furnace property ore, 2 miles east of Springfield, Springfield township. Ore above the Kittanning coal. (See Report KKK, p. 216.) Hard and tough; minutely crystalline; fracture irregular; color, light bluish gray.

738. *Fayette* furnace property ore, 2 miles east of Springfield, Springfield township. Iron ore under the Kittanning coal. (See Report KKK, p. 217.) Exceedingly hard and brittle; fracture, irregular; color, bluish gray.

	No. 150.
	Per cent.
Bisulphide of iron	0.052
Protoxide of iron	37.607
Sesquioxide of iron	3.214
Protoxide of manganese	1.776
c Protoxide of cobalt	Trace.
Alumina	1.634
Lime	6.600
Magnesia	2.594
Sulphuric acid	Trace.
Phosphoric acid	0.572
Carbonic acid	30.791
Water	1.350
Silicious matter	13.810
Total	100.000
Metallic iron	31.524
Metallic manganese	1.376
d Sulphur	0.028
Phosphorus	0.250
Phosphorus in 100 parts iron	0.793

150. *J. S. Magiffin*, 2½ miles southwest of Brookville, Rose township. Buhrstone iron ore. [Carbonate.] Exceedingly hard and tough plate-ore; full of small drusy cavities; fracture irregular, slightly conchoidal; color, brownish gray.

Lawrence county.—In the census year 70,296 tons of ore were mined in this county, principally at the horizon of the ferriferous limestone. The following analyses are from Report MM, pp. 189, 190, and 191:

	No. 753.	No. 752.	No. 750.	No. 751.	No. 754.	No. 756.	No. 755.	No. 757.
e	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	79.000	76.428	76.500	83.142	85.571	71.000	49.571	69.714
Bisulphide of iron	0.056	0.041	0.123	0.197	0.041	0.060	0.054	0.038
Sesquioxide of manganese	0.517	1.034	0.950	0.673	0.692	1.240	0.845	1.304
Alumina	2.980	1.331	0.914	0.732	1.775	1.321	1.720	1.410
Lime	0.480	0.710	2.160	0.510	0.380	6.070	19.950	5.500
Magnesia	0.396	0.564	0.940	0.360	0.432	0.979	0.540	0.945
Sulphuric acid	Trace.	Trace.	Trace.	0.007	Trace.	0.007	0.007	0.007
Phosphoric acid	0.572	0.831	0.936	0.346	0.600	0.625	0.199	0.238
Carbonic acid	None.	None.	1.697	None.	None.	4.770	15.370	4.100
Water	13.566	13.000	13.234	12.736	8.536	11.010	6.060	12.720
Insoluble residue	2.708	5.995	2.385	1.568	2.256	3.273	5.715	4.300
Total	100.275	99.934	99.839	100.271	100.283	100.356	100.031	100.276
f								
Metallic iron	55.326	53.519	53.607	58.292	59.919	49.728	34.729	48.818
Metallic manganese	0.360	0.720	0.663	0.469	0.482	0.864	0.576	0.908
Sulphur	0.030	0.022	0.066	0.108	0.022	0.035	0.032	0.021
Phosphorus	0.230	0.363	0.409	0.151	0.262	0.273	0.087	0.104

753. Ferriferous limestone ore, near Rose Point, 8 miles east from New Castle, Slippery Rock township. Bombshell-ore, used at Hope furnace. Hard, brittle bombshell-ore, the walls of the bombs being lined with fibrous, botryoidal, dark-brown iron oxide.

752. Ferriferous limestone ore, near Rose Point, 8 miles east from New Castle, Slippery Rock township. Ore used at Hope furnace. Generally compact and brittle, with dark-brown color; structure laminated; fracture irregular. Surface of specimen coated with light-brown, botryoidal iron oxide. a

750. *Houck & Granniss'* mines, 4 miles northeast of Chewton, Wayne township. Ferriferous limestone ore. Brittle; full of seams of ochreous iron ore; color, dark brown and yellowish brown; fracture irregular, rough.

751. *Houck & Granniss'* mines, 4 miles northeast of Chewton, Wayne township. Ferriferous limestone ore. Specimen curiously honeycombed; the cells partially filled with ochreous iron oxide; generally hard and brittle, with irregular fracture, showing kernels of pyrite.

754. *Houck & Granniss'* mines, 4 miles northeast of Chewton, Wayne township. Ferriferous limestone ore; keel-ore. The specimen consists of hard and tough deep-red ore, with thin (surface) layer of brown oxide; generally very compact and earthy-looking; fracture irregular.

756. *Houck & Granniss'* mines, 4 miles north of Chewton, Wayne township. Ferriferous limestone ore. Exceedingly hard and tough, with reddish-brown color and somewhat conchoidal fracture; irregularly seamed with brown oxide of iron. b

755. *Mr. Ziegler's* mines, 4 miles northeast of Chewton, Wayne township. Ferriferous limestone ore. Hard and tough, reddish-brown ore, with conchoidal fracture.

757. *Mr. Ziegler's* mines, 4 miles northeast of Chewton, Wayne township. Ferriferous limestone ore. Specimen irregularly seamed with brown oxide of iron; is exceedingly hard and tough, with reddish-brown color and conchoidal fracture.

Somerset county.—No ore was mined in this county in the census year. The following analysis is from Report MM, p. 181:

	No. 406.
	Per cent.
Protoxide of iron	44.357
Sesquioxide of iron	2.857
Bisulphide of iron	0.247
Protoxide of manganese	0.873
Alumina	3.220
Lime	1.210
Magnesia	1.690
Sulphuric acid	0.040
Phosphoric acid	0.338
Carbonic acid	29.860
Water	0.990
Carbonaceous matter	0.930
Insoluble residue	12.403
Total	99.015
Metallic iron	36.500
Metallic manganese	0.677
Sulphur	0.148
Phosphorus	0.148

c

d

406. *G. W. Clark's* ore-opening, at Hooversville. (See Report HHH, p. 120.) Carbonate ore; hard, compact, minutely crystalline; bluish gray. (D. McCreath.)

Westmoreland county.—No ore was mined in this county in the census year. The following analyses are from Report MM, pp. 179 and 180:

	No. 58.
	Per cent.
Protoxide of iron	51.271
Sesquioxide of iron	0.943
Bisulphide of iron	0.515
Protoxide of manganese	2.352
Alumina	2.050
Lime	1.344
Magnesia	0.814
Sulphuric acid	0.007
Phosphoric acid	0.537
Carbonic acid	33.980
Water	0.910
Carbonaceous matter	0.710
Insoluble residue	5.120
Total	100.553
Metallic iron	40.750
Metallic manganese	1.822
Sulphur	0.278
Phosphorus	0.229

e

f

58. Furnace-ore, on Jacob's creek, Mount Pleasant township, 2½ miles southeast of Jacob's Creek station. (See Report L, p. 105; also, Report KK, p. 123.) Compact, somewhat flaggy; irregularly seamed with white crystalline carbonate of lime; exceedingly brittle; bluish gray.

a

	No. 49.	No. 50.	No. 53.	No. 737.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	28.300	26.500	27.700	32.500
Sulphur	0.079	0.090	0.160	1.288
Phosphorus	0.137	0.046	0.679	0.152
Carbonate of lime	13.680	23.120	7.640	.....
Carbonate of magnesia	7.870	5.600	4.517	.....
Insoluble residue	13.885	13.810	25.240	15.130

b 49. Forge-ore, on Jacob's creek, 2½ miles southeast from Jacob's Creek station. (See Report L, p. 106.) Compact; bluish gray, with conchoidal fracture.

50. Coal-bank ore, on Jacob's creek, 2½ miles southeast of Jacob's Creek station, on the Pittsburgh and Connellsville railroad. (See Report KK, p. 122.) Crust hematitic; fresh fracture bluish gray, showing considerable calcite.

53. Bridge-ore, on Jacob's creek, 1½ miles northeast from Jacob's Creek station. Crust hematitic; bluish gray on fresh fracture; brittle; seamed with white crystalline carbonate of lime.

737. Iron-ore opening, on the Bedford pike, near old Washington furnace, 5 miles east from Ligonier, Ligonier township. About 25 feet above the Pottsville conglomerate. (See Report KKK, p. 217.) Crust hematitic, hard and tough; much spotted with pyrites; fracture irregular; color, bluish black.

B.—Of the Lower Barren Measures.

c

1. The Johnstown ore-bed.

The following notes are from Report MM, pp. 170 and 171:

The Johnstown ore lies in the lower rocks of the Barren Measures, and is an extensive ore-horizon of western Pennsylvania. It is minutely described in HH (pp. 118, 119, with analyses), and its place among the members of the great Mahoning sandstone group is indicated in Fig. 54, p. 111, where it is represented as 2 feet thick, as mined extensively by the Cambria Iron Company in the hills around Johnstown, east of the Conemaugh river.

It overlies the Freeport upper coal about 52 feet, as measured by Mr. Fulton (HH, p. 112), and is therefore to be placed between the lower and middle members of the Mahoning sandstone.

The Lamoreaux ore on Black creek (HH, p. 163), in the Armagh valley, may be the same bed; but it is rather identified by Mr. Platt with the Ritter furnace bed just overlying the Freeport upper coal (HH, p. 161, section p. 162).

d In Somerset county the Johnstown ore is recognized on Castleman's river (HHH, pp. 185, 186), resting on the upper of two members of the Mahoning sandstone, but only in nodules. It was worked once for Ben's Creek furnace along Mill creek (HHH, p. 216). Scarcely a trace of it is to be found around Ursina.

In the Ligonier Valley the Johnstown ore may be recognized perhaps in a bastard limestone over the Mahoning sandstone in Salt Lick township, Fayette county (KKK, p. 116); as a lean black shale ore *in* the Mahoning sandstone in Fairfield township, Westmoreland county (KKK, p. 163); as a ferriferous shale, 35 feet above the Freeport upper coal, in Saint Clair township (KKK, p. 175); and generally as a calcareous horizon *in* the Mahoning sandstone along the east flank of Chestnut ridge, and *on top* of it west of Chestnut ridge (allowing for the absence or presence of one or other member of the sandstone); like the Stewart ore near Meadow run; the Springfield mines ore on the Youghiogheny; the Weaver ore north from Falls city; the rich, good ore on the Clay pike in Mount Pleasant township, Westmoreland county; or as a dark ferruginous shale along the base of Laurel hill, like that once mined for Laurel Hill and Ross furnaces, always lean, and unaccompanied by limestone. (KKK, p. 215.) It was mined for Mount Pleasant furnace, on Jacob's creek, and also below the mouth of Indian creek.

The Johnstown calcareous ore lies directly on the Mahoning sandstone, in the region south of the Youghiogheny river and west of e Chestnut ridge. It is the Fairchance ore. (KK, p. 149.) On Cove run it is called the "limestone ore", 2 feet thick; and it is 2½ feet thick at Beattie's in North Union township. (KK, p. 120.) On Redstone it is in four layers in 5 feet of clay. It seems to be Hardman's 4-foot ore-bed in Preston county, West Virginia (see KK, p. 121); and the Haines' ore of Pride Vale furnace; and it seems to extend far south of the Baltimore and Ohio railroad. (See also KK, pp. 138, 165, 172, 186, 265, 318.)

In Indiana county the Johnstown ore is recognized 100 feet above the Freeport upper coal, in Fry's Hill section, on Rayne's run, a few miles from Marion, Indiana county (see HHHH, p. 257); and perhaps in the form of a ferruginous limestone at Five Points, on Plum creek, Indiana county. (See HHHH, p. 280.)

A regular and persistent bed of carbonate ore exists on Mill creek, Cambria county, and worked extensively for Schoenberger's furnaces on Mill and Ben's creeks. It is doubtless the Johnstown ore-bed. (HH, 132.)

Specimens representing the Johnstown ore have been analyzed from Cambria, Fayette, Westmoreland, and Indiana counties. The amount of iron varies from 11.10 to 35.93 per cent.

f

2. Carbonate ores over the Mahoning sandstone.

The following notes are from Report MM, pp. 167 to 169:

There are numerous ball ore-bearing shales in the (lower) Barren Measures, between the Philadelphia coal-bed and the Freeport upper coal.

In the country between the Chestnut ridge and the Monongahela river, ores show themselves at many places in the 300-foot interval between the Pittsburgh coal and the Green crinoidal limestone, but only in one place (below New Geneva, 115 feet beneath the Pittsburgh bed) as likely to be valuable. (See KK, p. 119.)

Over the Morgantown sandstone, and 155 feet beneath the Pittsburgh coal-bed, a stratum of calcareous ore from 1½ to 3 feet thick was once extensively stripped for the old Hermitage furnace, in Ligonier township, Westmoreland county. (KKK, pp. 140, 141.)

Connected with the Elk Lick coal and limestone at Elk Lick falls, Somerset county, is an excellent local deposit of carbonate ore, in three benches, 20 inches of ore in 4 feet of interval, more than 200 feet below the Pittsburgh coal. (HHH, p. 70.)

In Greene county, also, there are some low-grade ores about 200 feet beneath the Pittsburgh coal.

A very fair ore occurs about 325 feet beneath the Pittsburgh coal, below the mouth of Cheat river. (K, p. 384.) This is about the middle of the Barren Measures, near the Green crinoidal limestone. a

Under the Green crinoidal limestone ball-ore is abundant in Hampton township, Allegheny county. (Q, p. 160.)

Between the Green crinoidal limestone and the Mahoning sandstone are several horizons of ball-ore in the country between Chestnut ridge and the Monongahela river, one of which, lying higher than the Mahoning sandstone or Johnstown ore, is the Snake-den ore, on Georges creek, a fair-looking carbonate, 8 to 14 inches thick, and once extensively mined for Springfield furnace. (See KK, pp. 119, 120.) It has been stripped along Cove run, North Union township, Fayette county, for Lemont furnace.

About 400 feet below the Pittsburgh coal theoretically, or 220 feet above the Freeport upper coal actually, lies the Black Lick ore (described in HHHH, pp. 99, 102–106, 114), once mined for Black Lick and Buena Vista furnaces in eastern Indiana county. It lies just underneath the black fossil limestone, which itself becomes a lean and poor iron ore along the eastern edge of the Ligonier valley, north from the Loyalhanna, and was mined for Laurel Run furnace and old Washington furnace. (KKK, pp. 214, 215.) b

This ore may be represented in Cambria county by the siliceous ore-bed 150 feet above the Johnstown ore-bed (200 feet above the Freeport upper coal.) (See HH, p. 112.)

In the Pine Creek limestone, 450 feet below the Pittsburgh coal, ore occurs in East Deer and Indiana townships, Allegheny county. (Q, pp. 149, 154.)

In the Brush Creek limestone, 510 feet below the Pittsburgh coal, ore occurs on Davis run, Economy township, Beaver county. (Q, pp. 34, 183.) This may correspond to the Johnstown ore horizon of Cambria county.

C.—Of the Upper Productive Measures.

1. of the pittsburgh coal horizon.

The following notes and analyses are from Report MM, pp. 162 to 167:

Under the Pittsburgh coal-bed (from 4 to 6 feet) occurs, in southern Fayette county, an important deposit of ore formerly supposed to be confined to the Connellsville Uniontown basin, but recently found along the Monongahela river in the trough next west, sinking below water-level near Gray's distillery, above the mouth of Dunkard's creek. (See K, pp. 304, 383.) c

In Washington and Allegheny counties no traces of this ore have been found. (K, p. 384.) But in Fayette county, on the contrary, it is a most important horizon of ore, on which a number of furnaces have been and still are running with great success. Under the name of "the Pittsburgh Iron-Ore Group," with its various beds of blue-lump, condemned flag, big-bottom, red-flag, and yellow-flag ores, at Oliphant's, Springfield, and Lemont furnaces; at Fairchance, Monroe, Frost's station, New Geneva, Braddock's, on Scott's run, Cat's run etc., it is fully described in Report KK, on pages 111–118, 149, 170–181, 234–255, and 385, to which the reader is referred. (See index of iron ores, KK, p. 420.)

The analyses given under this section speak in sufficiently strong terms of the excellent quality of the ores. They show them to be generally very rich in iron and comparatively free from phosphorus: d

Fayette county.	469.	35.	36.
	Per cent.	*Per cent.*	*Per cent.*
Protoxide of iron	46.671	49.500	44.742
Sesquioxide of iron	8.285	0.700	0.818
Bisulphide of iron	0.034	0.020	0.272
Protoxide of manganese	1.311	1.636	1.059
Oxide of cobalt	Trace.	Trace.	Trace.
Alumina	1.606	1.153	2.795
Lime	1.740	1.859	3.119
Magnesia	1.001	2.018	3.870
Sulphuric acid	0.057	Trace.	Trace.
Phosphoric acid	0.161	0.204	0.096
Carbonic acid	31.790	34.900	34.450
Water	1.727	1.395	1.090
Carbonaceous matter	1.040	0.730	0.640
Insoluble residue	4.415	5.790	7.450
Total	99.838	99.905	100.401
Metallic iron	42.116	39.000	35.500
Metallic manganese	1.016	1.267	0.820
Sulphur	0.041	0.011	0.145
Phosphorus	0.070	0.089	0.042

e

469. *Dr. Fuller's* mines, about 3 miles southeast of Uniontown, in South Union township. Blue lump-ore. (See Report KK, p. 114.) Generally compact; minutely crystalline. Irregularly seamed with brown oxide of iron. Color, bluish gray.

35. *Oliphant Furnace* mines, in Georges township. Blue lump-ore. (See Report L, p. 99; also KK, p. 114.) Exceedingly hard and compact; minutely crystalline; color, bluish gray; fracture, conchoidal. f

36. *Oliphant Furnace* mines, in Georges township. Big-bottom ore. (See Report L, p. 99; also KK, p. 114.) Hard and compact, with thin seams of brown oxide of iron. Fracture, conchoidal; color, bluish gray.

Fayette county.	37.	38.	39.
	Per cent.	*Per cent.*	*Per cent.*
Iron	37.500	35.800	35.400
Sulphur	0.041	0.047	0.319
Phosphorus	0.505	0.083	0.069
Insoluble residue	5.670	9.560	10.450

a 37. *Oliphant Furnace* mines, in Georges township. Condemned flag-ore. (See Report L, p. 100; also KK, p. 111.) Compact and fine-grained; color, blue; fracture, subconchoidal.

38. *Oliphant Furnace* mines, in Georges township. Red flag-ore. (KK, p. 115.) Compact, fine-grained, reddish gray.

39. *Oliphant Furnace* mines, in Georges township. Yellow flag-ore. (KK, p. 115.) Crust hematitic; structure, flaggy; color, yellowish brown; on fresh fracture, bluish gray.

b

Fayette county.	No. 732*a*.	No. 732*b*.	No. 732*c*.	No. 552.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	31.000	37.500	38.150	29.200
Manganese	1.030	0.691	0.691	0.612
Sulphur	0.932	0.512	0.342	0.415
Phosphorus	0.151	0.123	0.121	0.268
Lime	4.680	3.530	3.860	3.380
Magnesia	5.405	3.459	2.828	3.012
Insoluble residue	8.855	4.735	3.360	19.240
Metallic iron in roasted ore	47.880	56.020	57.220	----------

732*a*. *Lemont Furnace* mines, 3 miles northeast of Uniontown. Ore immediately under the Pittsburgh coal-bed. Upper layer. (See Report KK, p. 116; also Report KKK, p. 228.) Comparatively soft and crumbling; structure laminated; color, grayish black. Specimen shows numerous small rounded pebbles consisting of the carbonates of iron, lime, and magnesia. Has the general appearance of a dried mud.

c 732*b*. *Lemont Furnace* mines. Pittsburgh coal ore Middle layer. Rather hard and tough; irregularly seamed with calcspar; contains small pits of white, pulverulent silicate of alumina. Fracture slightly conchoidal, inclining to rough; color, dark bluish gray.

732*c*. *Lemont Furnace* mines. Pittsburgh coal ore. Lower layer. Rather hard and tough, with irregular fracture and bluish-black color. Irregularly seamed with carbonate of lime, and white, pulverulent silicate of alumina.

552. *Lemont Furnace* mines, 3 miles northeast of Uniontown. Pittsburgh coal ore. Upper, middle, and lower layers, with a silicious layer, which is always rejected in mining.

By an error in labeling, these samples were analyzed as one. The analysis is merely given to show the utterly worthless character of the silicious layer. Analyzed by D. McC. (See Report KK, p. 116; also Report KKK, p. 228.)

d

	No. 700*b*.	No. 701*b*.	No. 702*b*.
	Per cent.	*Per cent.*	*Per cent.*
Iron	29.000	33.900	28.800
Sulphur	0.603	0.473	0.492
Phosphorus	0.208	0.112	0.135
Carbonate of lime	14.875	11.803	18.035
Carbonate of magnesia	6.485	4.691	4.601
Insoluble residue	9.540	5.540	10.030

700*b*. *Hoggsett, Watt & Co.'s* mines, at Braddock's station. Ore under the Pittsburgh coal. Upper layer. Second specimen obtained at 1,100 feet from the outcrop. (See KKK, p. 229.) Exceedingly hard and tough, with irregular fracture and grayish-black color. Spotted with pyrites; shows considerable calcareous matter.

701*b*. *Hoggsett, Watt & Co.'s* mines. Middle layer. Second specimen obtained at 1,100 feet from the outcrop. Exceedingly hard and tough; irregularly seamed with white crystalline carbonate of lime. Fracture conchoidal; color, grayish black and bluish black.

e 702*b*. *Hoggsett, Watt & Co.'s* mine. Lower layer. Second specimen obtained at 1,100 feet from the outcrop. Hard and tough, with irregular fracture and grayish-black and bluish-black color.

D.—Of the Upper Barren Measures (partly Permian).

The following notes are from Report MM, pp. 159 to 160:

There is scarcely a farm in Greene and Washington counties on which nodules of carbonate of iron are not plowed up. The ore-balls have been set free from the shales by the action of the air and frost, and there is hardly a stratum of shale or sandstone in the Barren Measures through which they are not disseminated, but no continuous beds are known to exist. (See K, p. 386.)

There is a local deposit of ore in the shales overlying the roof shales of the upper Washington limestone (No. VI of Stevenson's section to page 45, K), in Centre township, Greene county, near the headwaters of Pursley creek. (See K, p. 385.) The area is 2 miles long, and the amount of ore large; the ore is full of phosphorus, but otherwise good. This horizon of ore is about 800 feet over the
f Pittsburgh coal-bed. It was carefully examined all over the two counties, but yielded no ore elsewhere.

Below limestone No. V (of Stevenson's section to page 45, K), at many localities in Greene county, a good deal of ore occurs (K, p. 385), but the ore is rendered worthless by the large percentage of phosphorus.

Under the Washington lower limestone, and on the Washington coal-bed in Fayette county, at A. Struble's, in German township, is a considerable deposit of lean ball-ore. (KK, pp. 27, 245.)

Immediately above the little Washington coal-bed, in Greene county (525 feet above the Pittsburgh coal-bed), a little ore occurs in black shale, and a specimen was analyzed. (K, p. 384.) On Smith's creek, near Waynesburg, a moderate amount of ore was found also immediately above this coal-bed.

In the body of the Waynesburg coal-bed (375 feet above the Pittsburgh coal) are 5 feet of shales holding ball-ore loosely scattered. (KK, pp. 33, 228.)

Under the Waynesburg coal-bed in Greene county the shales contained very moderate quantities of ball-ore. (K, p. 384.) Some of it was once dug, at various points in Morgan township, for the old Clarksville furnace. This ore-horizon seems persistent.

V.—FOSSIL ORES.

OF THE CLINTON FORMATION.

A belt of these ores extends in a southwesterly direction through the middle counties of the state from Columbia county to the Maryland border. They have been largely mined along the Juniata river. The following notes and analyses are from Report MM, pp. 234 to 235; Report M, pp. 60 to 63, and Report M³, pp. 37, 38, 39, 41, 43, 45:

A detailed description of these beds will be found in Report of Progress F, on the Juniata district.

1. The Sand Vein ore-bed, the uppermost of the group, overlying the sand-rock or upper member of the ore sandstone. It is a hard, lean, calcareous ore below the drainage-level, but soft and comparatively rich from drainage-level up to outcrop. Sometimes it is represented by loose sand. Fossil impressions are numerous. (See F preface, pp. xxxv to xxxviii.)

2. The Danville ore-group of three or four beds underlying the ore sandstone and about 25 or 30 feet beneath the sand-vein ore. These beds are very variable, calcareous, fossiliferous, and from 4 to 8 inches thick. Sometimes they lie near enough together to allow 40 inches of ore to be taken out of a drift. They are softened into rich ore at the surface of the ground, and for 100, 200, or 300 feet down to drainage-level. (F preface, pp. xxxix to xl.)

3. The block-ore lies 150 feet beneath the Danville ore-group, and is called also the iron sandstone. It separates the Clinton upper from the Clinton lower shales. (F, p. xli.)

4. The Boyer block-ore lies 250 to 300 feet beneath the iron sandstone, and is 6 feet thick in Mahontongo gap.

5. The Bird-Eye fossil ore-bed occurs 100 to 150 feet above the base of the Clinton formation No. V, in the Clinton lower shales, and varies from 6 to 14 inches. (F, p. xlv.)

6. The Shot-Block ore-bed lies still lower, and if it be the same with R. H. Powell's ore-bed, southwest of Huntingdon, it lies close upon the Medina sandstone and sometimes attains a thickness of more than 20 feet, of which from 2 to 6 feet is soft ore. This may be the dye-stone ore of the southern states. (F, p. xlvii.)

Columbia county.—This county produced 22,588 tons of fossil ore in the census year. No analyses of the ore have been published in the reports of the second geological survey.

Montour county.—Product in census year, 33,890 tons. No analysis of an average sample is available.

Lycoming county.—The chief ore of this county is the fossil ore of the Chemung formation. The Clinton fossil has been mined here too, however. The following analyses are from Report M³, p. 44:

	138.	139.	140.
	Per cent.	*Per cent.*	*Per cent.*
Sesquioxide of iron	30.00	42.857	43.928
Sesquioxide of manganese	0.145	0.248	0.300
Alumina	5.051	5.975	4.568
Lime	1.100	1.720	1.300
Magnesia	1.116	1.037	1.000
Sulphuric acid	0.015	0.022	0.005
Phosphoric acid	0.439	0.868	0.694
Carbonic acid	1.227	1.289	1.075
Water	2.773	3.971	3.925
Silicious matter	58.120	41.980	42.520
Total	100.036	99.967	99.365
Metallic iron	21.000	30.000	30.750
Metallic manganese	0.101	0.173	0.209
Sulphur	0.006	0.009	0.002
Phosphorus	0.192	0.379	0.303
Phosphorus in 100 parts iron	0.914	1.263	0.985

138. *J. Young's* ore-bank, on the south side of the Susquehanna river, near Antes Fort, opposite Jersey Shore, and about 2 miles south from it. Fossil ore of V. Upper layer. Compact, fine-grained, sandy, with lenticular masses of slate; reddish brown.

139. *J. Young's* ore-bank, on the south side of the Susquehanna river, near Antes Fort, opposite Jersey Shore, and about 2 miles south from it. Fossil ore of V. Middle layer. Compact, fine-grained, sandy, with numerous shot-like phosphatic pebbles.

140. *J. Young's* ore-bank, on the south side of the Susquehanna river, near Antes Fort, opposite Jersey Shore, and about 2 miles south from it. Fossil ore of V. Lower layer.

Union county.—Only 663 tons of ore were mined in this county in the census year. The following analysis is from Report MM, p. 245:

	723.
	Per cent.
Iron	33.800
Sulphur	0.004
Phosphorus	0.358
Carbonate of lime	39.142
Carbonate of magnesia	2.497
Insoluble residue	3.851

723. *Union Furnace Company's* mines, at Winfield. Hard fossil-ore; Danville ore-bed. Exceedingly hard and tough, carrying small lenticular masses of slate; color, reddish brown and reddish gray.

a *Snyder county.*—Production of iron ore in the census year, 31,426 tons. The following analyses are from Report MM, pp. 242 and 245:

	103.	104.	99.	126.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	52.300	52.900	50.300	29.400
Sulphur	Trace.	0.011	0.006	0.056
Phosphorus	0.378	0.514	*a* 0.488	0.726
Insoluble residue	10.550	9.070	14.270	32.660

a My test for phosphorus in this specimen gave 0.485 per cent.

b 103. *Dr. J. D. Conrad's* ore-opening, 1¼ miles southwest of Beavertown. Sand-vein ore-bed, 24 inches thick, with 6 inches of jack in the middle; top bench of the vein. Compact, coarse-grained, showing spangles of quartz; color, iron rust. (D. McCreath.)

104. *Dr. J. D. Conrad's* ore-opening; upper part of lower bench. Compact, coarse-grained, wi h spangles of quartz. (D. McC.)

99. *Dr. J. D. Conrad's* ore-opening; lower part of vein. Compact, coarse-grained, with spangles of quartz. (D. McC.)

126. *Dr. J. D. Conrad's* ore-opening; jack of the vein. Specimen carries considerable intermingled slate, is very compact, and of a dark-brown and iron rust color.

c

	610.	
	Per cent.	
Sesquioxide of iron	77.714	=54.400 per cent. iron.
Sesquioxide of manganese	0.325	=0.226 per cent. manganese.
Alumina	5.654	
Lime	0.740	
Magnesia	0.410	
Sulphuric acid	0.065	=0.026 per cent. sulphur.
Phosphoric acid	0.771	=0.337 per cent. phosphorus.
Water	5.822	
Insoluble residue	8.315	
Total	99.816	

610. *Dr. J. D. Conrad's* ore-opening, 1 mile southwest of Beavertown, on the property of J. F. Middlesworth; sand-vein ore-bed, 26 d inches thick, with 6 inches of jack in the middle. This specimen from the bottom bench of vein. (See F, p. 37.) Represents clean ore. Compact, rather coarse-grained; reddish brown and iron rust.

	125.	127.	100.	925.	102.	725.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	43.100	52.600	49.900	52.100	42.750	48.800
Sulphur	0.010	0.023	0.006	0.032	0.021	0.028
Phosphorus	0.243	0.521	0.196	0.396	0.113	0.326
Insoluble residue	21.800	11.560	15.100	12.960	27.430	15.230

125. *Bloomsburg Iron Company's* ore-opening, 1 mile southwest of Beavertown, on the property of J. F. Middlesworth; sand-vein ore-bed. (See F, p. 37.) Compact, coarse-grained; reddish brown.

127. *John Earnest's* ore-opening, three-fourths of a mile southwest of Beavertown; sand-vein ore-bed. Vein 24 inches thick, with 6 e inches jack. (Bloomsburg Iron Company.) Compact, coarse-grained; reddish brown.

100. *John Earnest's* ore-opening; jack of the vein. (See F, p. 35.) Block fossil ore, showing spangles of quartz and specular iron ore; color, iron rust. (D. McC.)

925. *Bloomsburg Iron Company's* ore-opening, on property of Jacob Gross, southeast of Adamsburg; sand-vein ore-bed. Soft; reddish brown, spotted with quartz. (S. S. Hartranft.)

102. *Bloomsburg Iron Company's* ore-opening, on property of Jacob Gross, 1 mile southwest of Adamsburg. Ore comparatively soft, with considerable specular iron oxide; reddish brown. (D. McC.)

725. *Swengle & Dunning* ore-opening, on the property of Reuben Dreese, 1 mile southwest of Adamsburg; sand-vein ore-bed. Rather friable, argillaceous; reddish brown; shows numerous small spangles of quartz.

	724.	926.	128.
	Per cent.	*Per cent.*	*Per cent.*
Iron	45.125	32.455	50.500
Sulphur	0.015	0.094	0.024
Phosphorus	0.407	1.975	0.257
Carbonate of lime	10.928	.....	.....
Carbonate of magnesia	2.497	.....	.....
Insoluble residue	12.855	29.635	15.220

724. *Cruikshank & Brother's* ore-opening, on the property of Emanuel Duck, 2 miles from Smithgrove; bird-eye fossil ore. Compact, coarse-grained, brittle; fracture irregular; color, reddish brown.

926. Ore-opening 2 miles southeast of Smithgrove, on road leading to Freeburg; block-ore. Hard; reddish brown, with shot-like pebbles of impure phosphate of lime; spotted with quartz. (S. S. Hartranft.)

128. *Andrew Bickle's* ore-opening, 2 miles north of Freeburg, and 2½ miles southeast of Smithgrove; bird-eye fossil ore. Coarse-grained, brittle; reddish brown.

Mifflin county.—In the census year 29,333 tons of fossil ore were mined in this county. The following analyses are from Report M, pp. 60 to 63; Report MM, p. 242; and Report M³, p. 39: a

	II.	III.	IV.
	Per cent.	*Per cent.*	*Per cent.*
Iron	36.400	44.400	34.000
Sulphur	0.017	0.028	0.018
Phosphorus	0.184	0.115	0.124
Insoluble residue	35.200	28.880	35.480

b

II. *George M'Kee's* ore-bank, Ferguson valley, 7 miles west of Yeagertown; top portion of ore-vein good; whole vein about 18 inches thick. This part analyzed about 10 inches thick. Compact, silicious fossil ore of a dark-brown color.

III. *George M'Kee's* ore-bank, Ferguson valley, 7 miles west of Yeagertown; fossil ore vein 12 inches thick; this part (top) 8 inches thick; north dip in vein. Balance 4 inches in jack. Compact, sandy fossil ore of a reddish-brown color.

IV. *North of George M'Kee's* ore-bank, near James Shehan's house, in the meadow foot of Jack's mountain. Ore-vein about 12 inches thick; second specimen taken from heap of ore, being ore from shaft. Specimens mixed in proper proportions previous to analysis. Compact, sandy fossil ore of a deep-red color.

	V.
	Per cent.
Sesquioxide of iron	42.857
Alumina	7.816
Sesquioxide of manganese	0.093
Lime	0.448
Magnesia	0.738
Phosphoric acid	0.547
Sulphuric acid	0.122
Water	5.500
Insoluble residue	41.510
Total	99.631
Iron	30.000
Sulphur	0.048
Phosphorus	0.239

c

d

V. *George M'Kee's* ore-bank, Ferguson valley, 7 miles west of Yeagertown. Top bench of vein 6 to 12 inches thick; bottom part of vein, lower bench, 2 to 6 inches thick; face of gangway, 8 to 12 inches thick; top bench, south dip, average of vein. The analysis represents the above ores mixed in proper proportions. Compact, coarse, sandy fossil ore of a deep-red color, somewhat slaty.

	VI.	VII.
	Per cent.	*Per cent.*
Iron	39.800	42.300
Sulphur	0.011	0.010
Phosphorus	0.231	0.516
Insoluble residue	31.560	25.930

e

VI. *John Kinzer's* ore-bank, 5 miles northeast from M'Veytown. Soft fossil ore (medium); north dip, south anticlinal of ore-ridge; vein 1 foot thick. Fossil ore, compact, iron-rust color, with a tendency to break up into blocks.

VII. *Ferguson Valley* ore-ridge, 6 miles northeast from M'Veytown. Fossil ore (medium soft); John M'Cord ore-bank, No. 2 gangway. Fossil ore, compact and very hard, reddish-brown color, slaty structure, with much slaty gangue.

	XIII.	XIV.
	Per cent.	*Per cent.*
Iron	41.700	50.000
Sulphur	0.034	0.024
Phosphorus	0.212	0.606
Insoluble residue	27.640	14.784

f

XIII. *Ferguson* valley, 6 miles northeast of M'Veytown. John Rotherick ore-bank (soft medium fossil). In same ravine as John M'Cord ore-bank, on east side of ravine; north dip of ore-ridge; vein from 16 to 18 inches thick. Fossil ore, hard and compact, slaty structure; reddish-brown color, containing numerous particles of specular iron ore. Analyzed by S. A. Ford.

XIV. *Matilda* furnace, 1 mile north from Mount Union. Medium fossil taken from third level; vein 20 to 22 inches thick; vein overlying the ore sandstone. Fossil ore, compact, with slaty gangue; color, brownish red; ore has a tendency to break up into blocks. Analyzed by S. A. Ford.

a

	721.	722.
	Per cent.	*Per cent.*
Iron	26.100	46.900
Sulphur	0.051	0.005
Phosphorus	0.544	0.310
Carbonate of lime	47.018	.....
Carbonate of magnesia	2.240	.....
Insoluble residue	9.610	22.880

721. Iron-ore opening on property of J. H. Mann, Logan Gap. Hard fossil ore from Danville ore-bed. (See Report F, p. 17.) Hard,
b compact, coarse-grained; reddish brown and reddish gray.

722. Iron-ore opening on property of J. H. Mann, Logan Gap. Fossil ore from sand-vein ore-bed. (See F, p. 18.) Generally compact, and rather earthy; sparkles with scales of specular iron oxide. Color, pink and reddish brown.

c

	123.
	Per cent.
Sesquioxide of iron	71.571
Sesquioxide of manganese	0.682
Alumina	4.493
Lime	0.560
Magnesia	0.342
Sulphuric acid	0.035
Phosphoric acid	0.614
Water and organic matter	4.753
Silicious matter	16.950
Total	100.009
Metallic iron	50.100
Metallic manganese	0.475
Sulphur	0.014
Phosphorus	0.268
Phosphorus in 100 parts iron	0.534

d

123. *J. J. Dull's* ore-opening, in Oliver township, about 1¼ mile north of Dunkard church, on old mountain road, Jack's mountain. Fossil ore of V. Samples selected by Mr. Dull. Coarse-grained; oölitic; reddish brown. A portion of the specimen was in fine powder and rather argillaceous.

Juniata county.—Production in census year, 35,729 tons of fossil ore. The following analyses are from Report MM, pp. 229 to 241, and Report M³, p. 38:

e

	22.	928.	13.	19.	20.	21.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	44.600	41.273	46.000	47.900	51.900	24.800
Sulphur	0.012	0.020	0.009	0.008	0.005	0.005
Phosphorus	0.496	0.348	0.299	0.279	0.215	0.562
Insoluble residue	18.080	25.775	24.220	17.760	14.030	43.610

22. *Henry Aughey's* ore-opening, 4 miles northwest of Mifflintown and 3 miles west of the Juniata river. Hirsh & Hiestand, lessees. Block-ore; compact, rather coarse-grained; reddish brown.

928. *Samuel Aughey's* ore-opening, 2 miles southwest of the Juniata river. Specimen analyzed consisted of one-half jack and one-half ore, this being about the proportions in which they occur in the bed. Comparatively soft, reddish brown, with numerous small pebbles and some micaceous iron ore. (S. S. Hartranft.)

13. *Hirsh & Hiestand* ore-opening, south side of Lost Creek ridge. Sand-rock ore. Very hard and compact, with slaty structure and dark-brown color.

19. *Graham* ore-bank (No. 1), 4 miles northeast of Mifflintown, east of Juniata river. (Toll & Williams.) Vein 20 inches thick with 5 inches jack. Specimen analyzed consisted of three-fourths ore and one-fourth jack. Block-ore; compact, light brown, with some
f intermingled slate.

20. *Graham* ore-bank (Nos. 2 and 3), 4 miles northeast of Mifflintown and 1 mile east of Juniata river. Vein 2 feet thick. Ore specimen analyzed, 18 inches thick. Leased by Glamorgan Iron Company. Block-ore; coarse-grained; light brown and reddish brown, with numerous specks of quartz and specular iron ore.

21. *Graham* ore-bank (Nos. 2 and 3), jack from the vein. Compact, slaty; iron rust and various shades of brown.

	941.	29.	14.	23.	18.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	29.775	42.100	16.500	32.100	45.450
Sulphur	0.112	Trace.	0.249	0.010	Trace.
Phosphorus	0.351	0.338	0.122	0.257	0.246
Carbonate of lime	38.375	.....	12.172	34.250	.....
Carbonate of manganese	0.892	.....	2.662	3.465	.....
Insoluble residue	9.340	23.050	49.748	11.360	21.600

941. *William Nankwell's* ore-opening, 5 miles north from Mifflintown, on south slope of Lost Creek ridge. Hard fossil-ore from sand vein ore-bed. Hard, tough; reddish brown. Sparkles with calcareous matter. (S. S. Hartranft.) a

29. *William Nankwell's* ore-opening, 3½ miles west of the Juniata river. Block-ore; compact, coarse-grained; reddish brown.

14. *William Nankwell's* ore-opening, on A. Guss' property, 3 miles from Juniata river, Licking Creek valley. Vein 10 inches thick. Hard, sandy, calcareous; chocolate brown.

23. *William Nankwell's* ore-opening, on A. Guss' property, 3 miles from Juniata river, Licking Creek valley. Vein 14 inches thick. Hard, compact; reddish brown.

18. *Richard Nankwell's* ore-opening, Licking Creek valley. Compact; brownish black and reddish brown.

In the shot block-ore lying below the Bird-eye fossil-ore, and about 150 feet above the Medina sandstone, occur small rounded, shot-like pebbles. These consist for the most part of an impure phosphate of lime, as shown by the following analysis: b

	17.	
	Per cent.	
Lime	20.825	
Magnesia	0.486	
Phosphoric acid	16.208	= 35.38 per cent. phosphate of lime.
Oxide of iron	18.143	
Alumina	9.029	
Silica	35.540	
Total	100.141	

17. Phosphatic pebbles found in shot block-ore, on land of John Robinson, Lost Creek ridge, Licking Creek valley, Juniata county. (Report MM, p. 368.) c

Perry county.—Twenty-six thousand six hundred and fifty tons of fossil-ore were mined in this county in the census year. The following analyses are from Report M³, p. 37. The analyses represent the clean ore:

	117.	118.	119.
	Per cent.	*Per cent.*	*Per cent.*
Sesquioxide of iron	78.571	73.714	55.285
Sesquioxide of manganese	0.021	0.021	0.051
Alumina	4.927	5.702	7.553
Lime	0.510	0.390	0.650
Magnesia	0.213	0.209	0.400
Sulphuric acid	0.042	0.050	0.030
Phosphoric acid	1.502	1.784	0.382
Water and organic matter	6.015	9.075	5.690
Silicious matter	8.170	8.870	30.490
Total	99.971	99.815	100.531
Metallic iron	55.000	51.600	38.700
Metallic manganese	0.015	0.015	0.036
Sulphur	0.016	0.020	0.012
Phosphorus	0.656	0.779	0.167
Phosphorus in 100 parts iron	1.192	1.509	0.431

d

e

117. *B. G. Mush & Co.*, southeast side of Tuscarora mountain, one-fourth mile north from Millerstown, on the northeast side of the Juniata river. Sand-vein fossil-ore. Sample represents the quality of the greater part of the ore-bed, 10 to 12 inches thick. Rather coarse-grained and friable; reddish brown.

118. *B. G. Mush & Co.*, southeast side of Tuscarora mountain, one-fourth mile north from Millerstown, on the northeast side of the Juniata river. Sample represents the character of ore 3 to 4 inches thick in bed. Hard and tough; rather fine-grained; dark brown and reddish brown; small masses of shale in specimens.

119. On southeast side of Tuscarora mountain (Michael's ridge), one-fourth mile northwest of Millerstown, and a few hundred rods northeast of Juniata river. Fossil-ore of V, 8 inches thick; from ore sandstone, 7 feet from top. Compact; specimen consists of a mixture of hard and soft ore; reddish brown. (J. M. S.)

Huntingdon county.—This county produced, in the census year, 15,927 tons of fossil ore. The following analyses and notes are from Report M, p. 63; Report MM, pp. 237 and 238, and Report M³, p. 41: f

	a XV.	*a* XVI.		*a* XV.	*a* XVI.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sesquioxide of iron	72.571	72.428	Water	3.440	4.620
Alumina	4.723	4.211	Insoluble residue	18.650	17.000
Sesquioxide of manganese	0.320	0.269	Total	100.443	99.560
Lime	0.174	0.319			
Magnesia	0.309	0.432	Iron	50.800	50.700
Phosphoric acid	0.256	0.281	Sulphur	Trace.	Trace.
Sulphuric acid	Trace.	Trace.	Phosphorus	0.112	0.123

a The analyses represent the clean ore.

a XV. South side of Blacklog gap, No. 1 gangway, large underlying fossil-ore; vein 20 inches in thickness. Rockhill Coal and Iron Company. Compact; coarse fossil-ore; reddish-brown color.

XVI. South side of Blacklog gap, small overlying fossil-ore vein, Gangway No. 1. Rockhill Coal and Iron Company. Hard, compact fossil ore; chocolate-brown color, with somewhat laminated structure.

b

	XVII.	XVIII.	930.	929.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	28.800	27.250	46.500	34.300
Sulphur	Trace.	Trace.	0.025	0.038
Phosphorus	0.238	0.203	0.475	0.132
Carbonate of lime	39.132	36.007	17.550	None.
Carbonate of magnesia	6.976	1.180	1.551	None.
Insoluble residue	12.850	16.610	6.880	40.680

XVII. *Blacklog* gap, near Orbisonia. No. 1 north gangway. Hard fossil-ore. Fossil-ore, hard, compact; reddish color.

XVIII. North side of Blacklog gap, near Orbisonia. Bottom vein, Drift No. 1, 20 inches thick. Fossil-ore, hard, compact, with numerous small crystals of calcite, of a reddish-brown color.

930. Iron-ore opening, 1 mile northwest of McAleavy's fort. From old workings of Little furnace. Compact; showing considerable calcareous matter; fracture irregular; color, reddish gray and reddish brown.

929. Iron-ore opening, 3 miles west of McAleavy's fort. Surface specimen from old workings of Monroe furnace. Sandy, coarse-grained; dark brown and yellowish brown. Fracture rough, irregular.

c

d

	787.	
	Per cent.	
Sesquioxide of iron	71.500	= 50.050 per cent. iron.
Sesquioxide of manganese	0.643	= 0.448 per cent. manganese.
Alumina	5.825	
Lime	1.715	
Magnesia	1.248	
Sulphuric acid	0.069	= 0.028 per cent. sulphur.
Phosphoric acid	1.285	= 0.561 per cent. phosphorus.
Water	4.979	
Insoluble residue	12.385	
Total	99.649	

787. Iron-ore opening, 4 miles from Greenwood furnace. Fossil-ore from outcrop in ridge back of J. Barr's. Dip, southeast. Brittle, fossiliferous, reddish brown. Emits a strong argillaceous odor when breathed upon. (S. S. Hartranft.)

e

f

	128.	129.
	Per cent.	*Per cent.*
Sesquioxide of iron	71.571	42.928
Sesquioxide of manganese	Trace.	0.403
Alumina (by difference)	4.512	1.363
Lime	1.630	24.380
Magnesia	0.619	1.895
Sulphuric acid	Trace.	Trace.
Phosphoric acid	0.998	1.021
Carbonic acid	None.	19.710
Water	4.940	1.900
Silicious matter	15.730	6.400
Total	100.000	100.000
Metallic iron	50.100	30.050
Metallic manganese	Trace.	0.281
Sulphur	Trace.	Trace.
Phosphorus	0.436	0.446
Phosphorus in 100 parts iron	0.870	1.484

128. On property of Dull & Bradley, three-quarters of a mile south of Mapleton. White and red. Fossil-ore of V. Soft fossil. Comparatively soft; shows small scales of specular iron ore; color, various shades of brown. (J. M. S.)

129. On property of Dull & Bradley, three-quarters of a mile south of Mapleton. White and red. Fossil-ore of V. Hard fossil. Compact; brittle; dark brown and reddish brown. (J. M. S.)

Blair county.—In the census year 40,636 tons of fossil-ore were mined in this county. The following analyses are from Report MM, pp. 235 to 237:

	646*a*.	646*b*.
	Per cent.	*Per cent.*
Sesquioxide of iron	30.857	19.285
Sesquioxide of manganese	0.053	0.046
Alumina	2.850	1.828
Lime	31.530	38.160
Magnesia	0.865	0.846
Sulphuric acid	0.060	0.085
Phosphoric acid	1.092	0.417
Carbonic acid	23.778	30.205
Water	1.885	1.015
Insoluble residue	7.090	8.315
Total	100.000	100.202
Metallic iron	21.600	13.500
Metallic manganese	0.035	0.032
Sulphur	0.024	0.034
Phosphorus	0.477	0.182

646*a*. *Hollidaysburg* double fossil-ore, upper layer. Compact, fossiliferous, showing considerable calcareous matter; reddish brown.
646*b*. *Hollidaysburg* double fossil-ore, lower layer. Compact, fossiliferous; reddish gray and reddish brown.

	645.	712.	962.
	Per cent.	*Per cent.*	*Per cent.*
Sesquioxide of iron	74.285	67.285	69.357
Sesquioxide of manganese	0.072	0.278	0.014
Alumina	7.392	7.044	6.285
Lime	0.960	0.550	0.910
Magnesia	0.552	0.569	0.551
Sulphuric acid	0.077	0.082	0.008
Phosphoric acid	0.758	0.398	0.768
Carbonic acid	Traces.	Traces.	None.
Water	4.962	6.190	5.167
Insoluble residue	11.115	17.855	17.230
Total	100.173	100.251	100.290
Metallic iron	52.000	47.100	48.550
Metallic manganese	0.050	0.194	0.010
Sulphur	0.031	0.033	0.003
Phosphorus	0.331	0.174	0.327

645. *Hollidaysburg and Gap Iron Company's* mine, McKee's Gap. Lump-ore. Compact and tough; full of seams of ochreous iron ore and spangles of specular iron oxide. Color, generally reddish brown.

712. *Hollidaysburg and Gap Iron Company's* mine, McKee's Gap. Second sample, consisting of two-thirds lump-ore and one-third fine ore. Lump-ore has the general appearance of first specimen. Fine ore is for the most part a yellowish ochreous mud, rather lean in iron.

962. *Sarah Furnace* ore-bank, on Dunning's mountain, near Sarah furnace. Dark reddish brown; brittle; full of fossil pits, for the most part filled with specular iron ore. Emits a strong argillaceous odor when breathed upon.

OF THE CHEMUNG FORMATION.

These have been long known as the Mansfield ores of Tioga county, reported on first in 1841 by J. P. Lesley (published in 1858, *Geology of Pennsylvania*, vol. 1, p. 311), and then in greater detail in 1875 by Mr. Sherwood (published in 1878, *Report of Progress G*, pp. 33 to 37, 41, 42, 67).

The series consists of three beds: 1. *Upper* or *Spirifer* bed; 2. *Middle* or *Fish* bed; and, 3. *Lower* ore-bed.

The *Upper* or *Spirifer* bed is full of shells, but contains no fish remains. It lies about 200 feet below the base of the Catskill red rocks of Formation No. IX. Near Mansfield it is from 2 to 3 feet thick; on Lamb's creek, from 1 to 3 feet thick. (G, pp. 60, 61.)

The *Middle* or *Fish* bed is oölitic, and very similar to the Clinton fossil ores of middle Pennsylvania, yields remains of *fish* (*Diplodus; Heliodus*), and is ground for paint. It lies 200(?) feet beneath the upper ore-bed at Wilcox's, on Mann's creek (G, p. 61), and is opened in many places, as at Roseville (4 feet thick); Whipple's hill; Bixby's hill; on Elk run, at Covington; Oak hill; Clark's hill; Austenville (where it thicken's to 6 and 7 feet); Columbiana, etc. (G, p. 66.)

The third or *Lower* ore-bed, on Tioga river, back of Shaw's, is described on p. 61, G, as from 100 to 200 feet beneath the Middle bed. It contains small flattened pebbles of quartz.

At Canton Corners, Bradford county, two beds, separated by 8 feet of shale, yield 5 feet of ore, under a roof of shaly Chemung limestone, 10 feet thick, full of fossils. (G, p. 41.)

Mr. Sherwood discovered one of the Mansfield ore-beds on a sharp anticlinal in Lycoming county, in front of the Alleghany mountain; and traces of this deposit have been seen elsewhere in middle Pennsylvania, as in Huntingdon county (see Report F, p. 235), where they have been referred to the Larry's creek ore; and, since they lie 13 feet beneath the bottom of the *transition* layers of IX and VIII, they may represent, under a very much changed aspect, the upper Mansfield ore-bed. (Report MM, pp. 229 and 230.)

a The following analyses are from Report MM, pp. 231 to 232, and Report M³, pp. 34 to 36, 41 and 45:

Tioga county.	319.	198.	318.	335.	317.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Iron	42.800	38.900	32.400	43.100	35.300
Sulphur	0.018	0.063	0.065	0.018	0.026
Phosphorus	0.903	0.603	0.585	0.657	0.215
Lime	.....	13.100	9.170	1.800	4.740
Magnesia	.....	2.140	2.918	0.922	.....
Insoluble residue	21.670	11.565	23.890	20.910	28.845

b

NOTE.—Dr. McCreath writes: "These analyses may serve to show the character of the Mansfield ore-beds, but it is doubtful if the samples represent the average ore to be mined."

319. *Upper* or *Mansfield* ore-bed, on Andrew Shaw's farm, 2 miles northeast of Mansfield, Richmond township. Upper vein, 3 feet thick. (See G, p. 61.) Compact, coarse-grained; reddish brown.

198. *Upper* or *Mansfield* ore-bed, about 3 miles west of Mansfield. (See G, p. 60) Compact; deep red; shows considerable calcareous matter.

318. *Upper* or *Mansfield* ore-bed, on lands of G. R. Wilson, 3 miles northwest of Mansfield, Lamb's creek, Richmond township; 18 inches thick. (See G, p. 60.) Compact, coarse-grained; reddish brown.

335. *Lower* or *Third* ore-bed, 1 mile northwest of Mansfield. Outcrop in the bed of the Tioga river. (See G, p, 61.) Hard and compact, with small flattened quartz pebbles; color, generally reddish brown. (D. McCreath.)

c 317. *Middle* or *Second* ore-bed, 1½ miles south of Mansfield, on Bixby's hill. Fine-grained; reddish brown. (D. McCreath.)

Tioga county.	324.	323.	322.	321.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	39.300	31.300	37.000	28.900
Sulphur	0.027	0.018	Trace.	0.015
Phosphorus	0.184	0.229	0.241	0.298
Insoluble residue	34.400	44.420	36.370	44.980

Ore-openings on the lands of Mr. Hermon and Mr. Meetem, 1 mile southeast of Ogden's Corners, Union township. (See G, pp. 33, 34.)

324. Ore from the top band, 4 feet thick. Compact, fine-grained; dark reddish brown.

d 323. Ore from the second band, 1 foot 5 inches thick. Compact, fine-grained; reddish brown.

322. Ore from third band, 8 inches thick. Compact, fine-grained; reddish brown and reddish gray.

321. Ore from bottom band, 1 foot thick. Compact, sandy; reddish brown (D. McCreath)

Perry county.	112.
	Per cent.
Metallic iron	35.775
Sulphur	0.010
Phosphorus	0.731
Silicious matter	31.740
Phosphorus in 100 parts iron	2.043

e

112. *Cumbler* property, Miller township, one-half mile northwest from the Cook property, on left side of ravine. Dr. Harry Stites, Newport. Montebello fossil ore. Rather coarse-grained, argillaceous; reddish brown.

Perry county.	113.	114.	115.	116.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	41.714	33.428	44.143	40.714
Sesquioxide of manganese	0.110	0.220	0.352	0.042
Alumina	9.037	12.143	9.381	3.764
Lime	0.560	0.610	0.570	0.230
Magnesia	0.428	0.536	0.407	0.583
Sulphuric acid	0.025	0.025	0.037	0.029
Phosphoric acid	1.399	0.719	1.376	0.478
Water and organic matter	10.745	7.385	9.685	4.485
Silicious matter	35.620	44.690	34.070	48.980
Total	99.638	99.756	100.021	99.305
Metallic iron	29.200	23.400	30.900	28.250
Metallic manganese	0.079	0.158	0.253	0.030
Sulphur	0.010	0.010	0.015	0.011
Phosphorus	0.611	0.314	0.601	0.209
Phosphorus in 100 parts iron	2.092	1.341	1.945	0.739

f

NOTE.—Mr. McCreath writes: These samples "represent the fossil ore of VIII, and the analyses show about what the average ore yielded in the furnace. Not much of the ore used."

113. *George Peterman's* land, Duncannon Iron Company, lessees; Polecat valley, in Mahonoy valley, on the southeast side of Mahonoy ridge, 3 miles southwest of Juniata river. Montebello ore. Top division of ore, upper bed 8 inches to 10 inches thick. Soft, crumbling, shaly; dark brown; structure somewhat laminated. a

114. *George Peterman's* land, Duncannon Iron Company, lessees; Polecat valley, in Mahonoy valley, on the southeast side of Mahonoy ridge, 3 miles southwest of Juniata river. Montebello ore. Middle division of ore = the bottom division of the upper ore-bed; 8 to 10 inches thick. Soft, crumbling, very shaly; reddish brown.

115. *George Peterman's* land, Duncannon Iron Company, lessees; Polecat valley, in Mahonoy valley, on the southeast side of Mahonoy ridge, 3 miles southwest of Juniata river. Montebello ore. Top bed of ore. Soft ore, 18 inches thick. Comparatively soft, shaly; reddish brown.

116. *George Peterman's* land, Duncannon Iron Company, lessees; Polecat valley, in Mahonoy valley, on the southeast side of Mahonoy ridge, 3 miles southwest of Juniata river. Montebello ore. Bottom bench of ore = lower of the two ore-beds, 8 inches thick. Rather coarse-grained and sandy; full of fossil casts; somewhat porous; reddish brown. b

Lycoming county.	141.	142.	143.	144.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sesquioxide of iron	40.714	46.643	49.857	42.857
Sesquioxide of manganese	0.103	0.300	0.248	0.186
Alumina	5.269	5.476	3.774	4.690
Lime	1.620	1.760	6.270	1.450
Magnesia	0.828	1.030	1.693	0.881
Sulphuric acid	Trace.	Trace.	Trace.	Trace.
Phosphoric acid	0.907	1.101	1.759	0.863
Carbonic acid	None.	None.	2.590	None.
Water	3.710	4.310	4.060	3.705
Silicious matter	56.630	39.220	29.130	44.830
Total	99.781	99.840	99.381	99.462
Metallic iron	28.500	32.650	34.900	30.000
Metallic manganese	0.072	0.209	0.173	0.130
Sulphur	Trace.	Trace.	Trace.	Trace.
Phosphorus	0.396	0.481	0.768	0.377
Phosphorus in 100 parts iron	1.389	1.473	2.200	1.256

c

141. *McGowan* mine, Piatt township, 2 miles northeast from Jersey Shore, Stewart's run. Fossil-ore of VIII. Generally compact, highly fossiliferous, with some phosphatic pebbles; color, reddish brown. d

142. *Quiggleville* mine, at Quiggleville, 1 mile northwest from Perryville, Lycoming township, just south of Mr. Stiber's house. Chemung fossil-ore. Rather compact and fine-grained; fossiliferous, with some phosphatic pebbles; color, reddish brown.

143. *Hayes* mine, on Lycoming creek, Hepburn township, one-third mile north of Cogan Station, Northern Central railroad. Chemung fossil-ore. Rather coarse-grained; highly fossiliferous; carries numerous phosphatic pebbles; color, reddish brown and reddish gray.

144. *Furnace Run* mines, on the north side of Furnace run, close to the south line of Watson township, and near the old Safe Harbor furnace, 6 miles northwest of Jersey Shore. Chemung fossil-ores. Rather fine-grained, fossiliferous, shaly; reddish brown.

REPORT ON CERTAIN MAGNETITES IN EASTERN PENNSYLVANIA.

By Bailey Willis.

Within the area of Mesozoic red sandstone in eastern Pennsylvania there are several deposits of magnetic ore of great economic value and peculiar geologic relations. Their chemical composition, the associated minerals, and the wall-rock are essentially different from those of the neighboring magnetites of New Jersey, and afford a distinct set of geologic facts worthy of much more detailed study than has been given them. c

The deposits thus referred to are the Dillsburg magnetic mines; the Great Cornwall mine, near Lebanon, Lebanon county; the Jones mines, near Springfield, Berks county; the Hopewell, Saint Mary's, and French Creek, in western Chester county; the Wheatfield and Fritz' Island, near Reading, and the Boyertown mines.

Of these the Cornwall mine is the largest and best known, and what little study the deposits have received has centered in that.

The description given by Professor Rogers, in the *Report of the First Geological Survey of Pennsylvania* (Vol. II, page 718), the paper by Professor T. Sterry Hunt (*Proc. Am. Inst. of M. E's.*, Vol. IV, page 319), and an account by Professor Hans Höfer, in the *Report of the Austrian Commission to the Centennial Exposition*, called "Die Kohlen und Eisenerz-Lagerstätten Nordamerikas" (page 241), are the only publications relating to these mines I have seen. My own observations were made in June and July, 1881, while visiting the mines to collect samples for d the Tenth Census. They are by no means as detailed as I could desire, but some of the facts noticed and the maps of the mines obtained are of importance.

The three writers on these deposits differ greatly in their opinions. Professor Rogers says, under the heading "Iron Ores of the Metamorphic or Gneissic Rocks" (Vol. II, p. 713):

> The magnetic iron ore occurs only in the form of true veins of injection or genuine mineral lodes.

And in the same paragraph:

> These iron ores evidently reached the positions in which we thus find them while in a melted state.

Writing of the French Creek deposits, near Knauertown, he says (Vol. II, p. 706):

> The predominant metalliferous injections are veins or lodes of magnetic oxide of iron.

And on page 707, of the Leighton mine: e

> A large surface excavation, embracing two veins of igneous magnetic iron ore.

On page 708, however, he says of the Warwick mine, near Saint Mary's:

> This extensive and interesting body of iron ore is in reality not a genuine lode or igneous intrusive vein, though the ore derives some of its characters from intrusive igneous action, but is a bed or deposit at the base or very near the base of the middle secondary red sandstone, which here laps upon the gneiss.

At the bottom of the same page he refers to the ore as having been originally a hematite, but altered by igneous action.

On page 718 he describes the ores of the primal series as follows:

> The slates of the primal series, especially the upper primal slates, yield two classes of iron ore—one a very ferruginous variety of f the rock itself, under conditions of more or less metamorphism; the other a class of rich brown hematite iron ore of superficial formation. To the first class belong the valuable and noted mines of Cornwall, in Lebanon county, the Jones mine, in Berks, and partially the Chestnut Hill mine, near Columbia, and some of the ore-diggings near Safe Harbor.

Referring particularly to the Cornwall mine, he goes on:

> At this locality the actions collecting the oxide of iron into its present conditions have been somewhat complicated. The ferruginous primal slate has been metamorphosed, and its oxide of iron segregated and crystallized through the influence, probably, of highly-heated volcanic steam, and the same influence has produced a very general cleavage structure. During the same action, or subsequently, numerous injections of molten hot lava, resulting in dikes of trap-rock, have invaded the stratum, and have still further changed the condition of the mass, infusing among it, probably by sublimation, some trappean mineral matter, and especially some sulphuret and carbonate of copper; and since these subterranean influences, the atmosphere, through its rains, has exerted itself through countless ages to modify still further the chemical and physical conditions of the shattered and fissured mass and its contained oxide of iron.

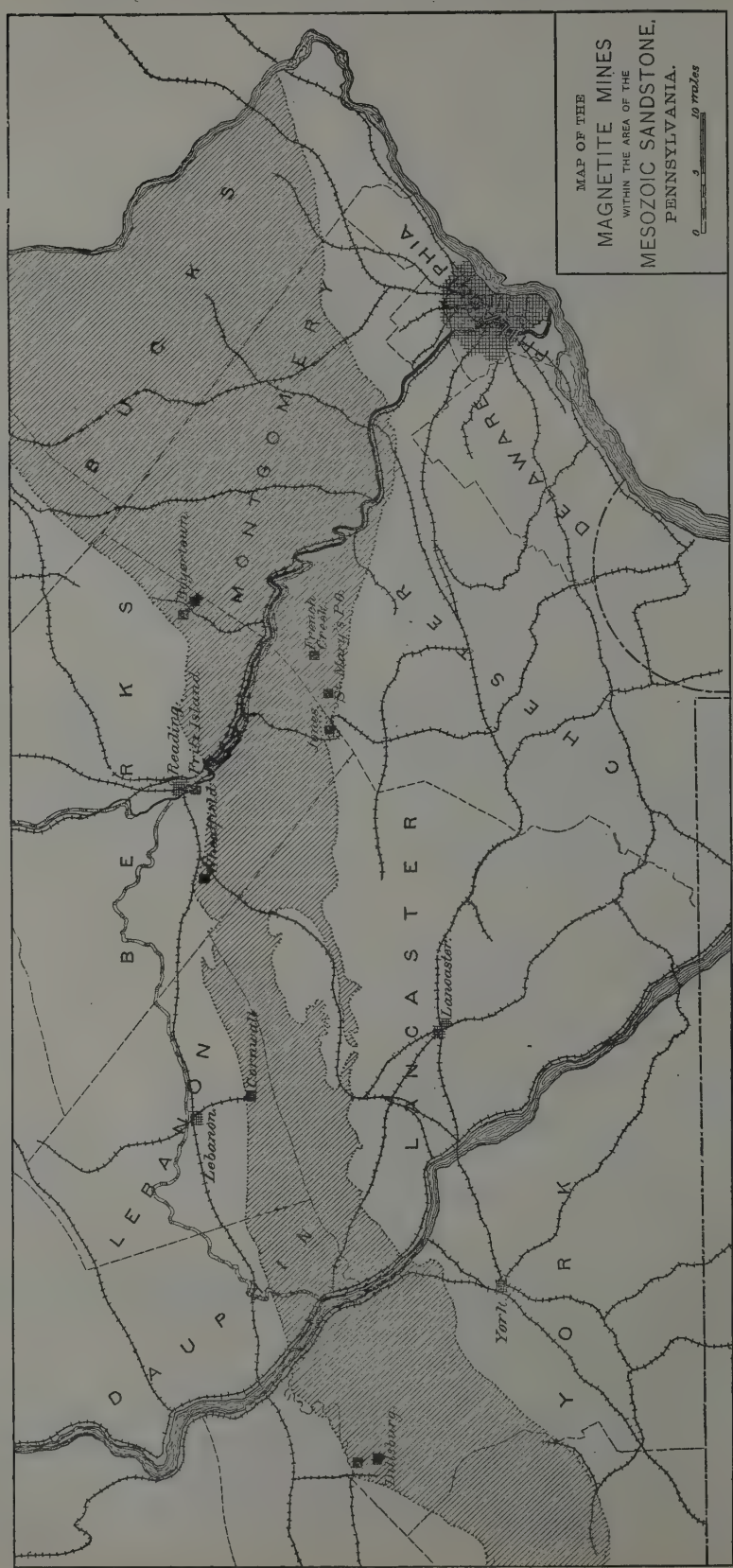

MAP OF THE
MAGNETITE MINES
WITHIN THE AREA OF THE
MESOZOIC SANDSTONE,
PENNSYLVANIA.
0
5
10 miles
BERKS
MONTGOMERY
BUCKS
DELAWARE
CHESTER
LANCASTER
YORK
DAUPHIN
LEBANON
Reading
Trick Island
Lebanon
Lancaster
York
Harrisburg

FIG. 57.

Professor Rogers thus considers some of these magnetites to be of igneous origin, and some to be metamorphic; **a** the Warwick mine, at Saint Marys, he assigns to the Mesozoic, the Cornwall and Jones mines to the upper primal slates, which directly overlie the primal white sandstone or Potsdam sandstone.

Professor T. Sterry Hunt, in his paper on these ores, says (*Transactions of American Institute of Mining Engineers*, Vol. IV, p. 319):

> These ores were, by Professor H. D. Rogers, referred to what he designates as the primal slates, which he regarded as the lowest member of the Paleozoic series; though by some later observers the Cornwall mine and certain related deposits west of the Susquehanna have been referred to the Mesozoic sandstone. It would be foreign to my present purpose to set forth the reasons which lead me to conclude that they are, all of them, really contemporaneous deposits included in the primal slates, which correspond to a portion of the Lower Taconic series of Emmons, and belong, in my opinion, to a lower horizon than the Potsdam sandstone of the New York system. **b**

Professor Hunt thus refers the ores to the lower primal slate, which is separated from the upper by the Potsdam.

Professor Höfer considers the trap at Cornwall not an eruptive rock.

The almost constant associates of these ores are a light-green slate, which is interstratified with them, a crystalline limestone, the Mesozoic red sandstone, and trap- (dolerite) dikes. The constantly-occurring intermingled minerals are pyrite, chalcopyrite, and carbonates of copper and calcite. Dr. Genth gives many others in his report on the mineralogy of Pennsylvania for the second geological survey, but they are not of sufficient consequence to be cited here.

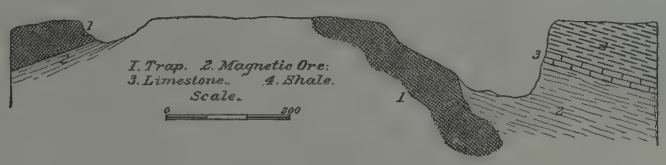
The French Creek mines and those near Saint Mary's differ from the others by the absence of stratified limestone, and the bedding of the ore in gneiss, which is not seen in Boyertown, Fritz island, Wheatfield, Cornwall, or Dillsburg. At all the latter the limestone is an important associate. Professor Rogers, in his description of Cornwall, has the **c** following (Vol. II, p. 720):

> In the pit large masses of light-blue, flinty, and magnesian limestone are found imbedded with and surrounded by ore; they are devoid of regular form. In like manner masses of quartz are found as bunches in the bedding of the slaty ore. The limestone is evidently not *in situ*.

The developments made at Cornwall since Professor Rogers' observations show that the limestone is distinctly stratified, and occurs as indicated in the section of that mine. At Jones' the limestone is conformable to the stratified underlying ore, which becomes more calcareous as it approaches it, and there is no marked line of division. At Boyertown a limestone bed 175 feet thick lies between the Warwick and the old Gable workings. At Fritz island and Wheatfield the ore is associated with the Potomac marble, a limestone breccia; and at Dillsburg the limestone forms the foot-wall of the ores. The relative position of the limestone to the ore may be open to **d** discussion; but that it had a definite stratigraphical position which, disturbed as the deposits are, may yet be determined, hardly seems doubtful.

The following is a description of the individual mines, with such observations on their geology as the writer was able to make:

Jones' mine, 1 mile north of Springfield, Berks county, presents the simplest structure. There are two open-cut workings on stratified ore, both dipping away from a body of trap which lies between.



e

Approximate Section of the Jones' Mine.

FIG. 58.

In the northern pit the ore dips 16° N. 55° W. The contact between the ore and the underlying trap has been well exposed in the south side of the cut. Above the ore is a limestone-bed conformable to it, about 12 to 15 feet thick, and above that still is a conformable light-green, earthy shale. If it should prove that this shale belongs to the Mesozoic sandstone, the ore is probably of the same age; but this shale has no resemblance to any of Mesozoic **f** age that the writer has seen, and it seems more probable that it corresponds to an overlying ore-stratum found in some of the other mines, but here devoid of magnetite.

The conformability between the ore, limestone, and shale points to their having a common geological age. The body of the ore is a black magnetite, interstratified with light-green slate, and containing pyrites, calcite, and chalcopyrite. The upper layers pass from this into a crystalline marble with grains of magnetite, and these become fewer as the limestone is approached, pointing to the deposition of the ore as a sediment in a shallow sea, which gradually deepening, afforded the conditions for the formation of limestone.

In the southern opening, about 300 yards from that just described, the ore lies beneath a trap-dike, dipping about 25° to the southeast. The foot-wall has not been reached. The ore is much oxidized and contains much less pyrites than that from the northern cut.

FIG. 59.—MAP OF THE CORNWALL MINE, LEBANON COUNTY, PENNSYLVANIA.

The structure of the entire deposit is that of an anticlinal, broken through at the top of the arch by the trap. a
The following are the analyses of the samples taken from the ore on stock-pile at the two openings:

	North cut.	South cut.
	1424.	1425.
	Per cent.	*Per cent.*
Metallic iron	45.26	51.32
Phosphorus	0.027	0.025
Phosphorus in 100 parts iron	0.060	0.049

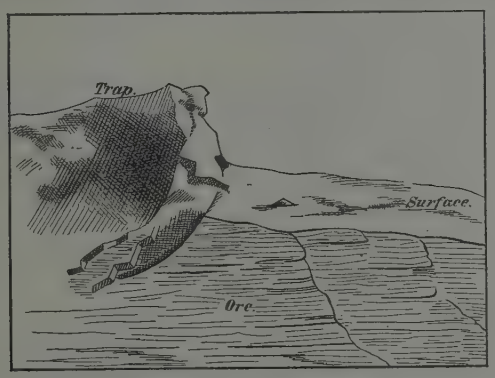
b

The Cornwall mine is opened on an enormous deposit of magnetic ore, 4,500 feet in length from east to west and 400 to 900 feet in width from north to south. On the west, north, east, and southeast it is bounded by a wall of trap; on the remaining south side, 3,200 feet in length, the ore disappears under the Mesozoic sandstone.

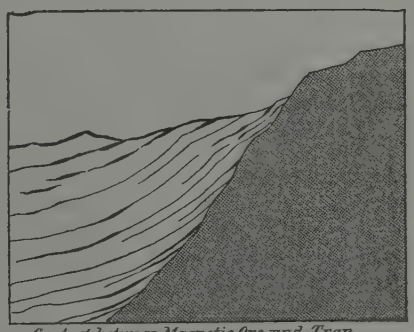
Two streams, flowing northward across the deposit, have cut it into three hills—Big hill on the east, Grassy hill on the extreme west, and Middle hill between. Big hill is 312 feet above the creek at its base; Middle hill, 98 feet; and Grassy hill, 78 feet (Rogers, Vol. II, p. 719).

Surrounded on the south, east, and north by converging walls of trap, the ore of Big hill lies in a basin like the bowl of a spoon; a hole sunk at the western part of the hill struck trap after passing through 30 feet of ore. The southern rim of this basin sinks beneath the surface just west of Big hill, while the northern edge, notched c by the little stream, reappears north of Middle hill, and again on the north and west of Grassy. The basin deepens going westward from Big hill; east of Middle hill the trap was found in three holes sunk 134 feet, 179 feet, and 240 feet below the level of the creek, the deepest being nearest the sandstone on the south. On the western slope of Middle hill a hole was sunk 325 feet through ore, and, according to Mr. J. T. Boyd, the engineer in charge, no trap was found.

The structure of the ore throughout the entire exposure is that of a stratified deposit. In Big hill the strata



Trap Dyke, Big Hill.
FIG. 60.



d

Contact between Magnetic Ore and Trap Big Hill. Cornwall, Pa.
FIG. 61.

e

are essentially horizontal, though in places the intrusion of small trap-dikes has disturbed the mass, and along the sides the stratification is bent upward parallel to the great bounding walls of trap.

In Middle hill the dip is about 30° to the north, but it is much disturbed. A piece of the slate which occurs interstratified with the ore is shown in the accompanying sketch:

f

FIG. 62.

a The limestone, associated with the ore, occurs in isolated areas on Middle and Grassy hills; there is none on Big hill. In the accompanying section(Fig. 59) the principal occurrences of limestone are shown. Descending from the trap and crossing the ore-deposit on Grassy hill, one comes upon the limestone apparently dipping 30° under the ore toward the trap. Crossing the little knoll of limestone, it is seen conformably overlying the ore. Hence, this limestone either lies in the ore, between two separate strata, or it lies upon the ore, and the apparent dipping under is really a fault. Crossing the little brook to Middle hill, one finds a limestone near the foot of the slope. It ends abruptly near a steep ascent to the top of the hill, which is here covered by pebbles of the decomposed red sandstone; but south of the section-line a considerable area of the summit is formed of limestone, overlying the highest ore.

b Coming down to the southeast side of Middle hill, there is an outcrop of limestone, which appears, as on Grassy hill, to dip under the ore, but from beneath which the ore has been mined in a long drift.

Comparing this deposit with the very similar one at the Jones' mine, and considering the large areas over which the limestone lies above the ore, it seems probable that it was laid down upon it; that at Grassy hill a triangular prism of ore, bounded on the north and west by the fissures now filled with trap and on the southeast by a fault, was carried up in the outburst and placed in its apparent position above the limestone; and that a similar uplifted area forms the greater part of Middle hill, bounded on the west by a nearly north and south fault, on the north by the trap, and on the southeast by a fissure, partly located by the apparent dipping of the limestone under the ore.

At the foot of the eastern slope of Big hill, about 300 yards from the summit, is an old ore-pit, called the c "Elizabeth opening". This ore lies east of the trap, which surrounds the deposit on Big hill, and it cannot be ascertained definitely whether the great dike extends all the way between the two ore-beds or not. The fragments on the surface indicate that it probably does, and that the Elizabeth ore is a small pocket, separated from the main body in the upheaval.

A mile still farther east is another old ore-pit, now caved in. Of it Professor Rogers says (Vol. II, p. 720):

> A small ore-pit, from which no ore is at present extracted, known as the Dover mine, is situated 1½ mile east of Cornwall. The ore, though of the magnetic variety, appears in irregular bunches and nests. No trap interjections are found in the vicinity. The deposit is quite near the limestone, and is intermixed with sand and gravel.

It is much to be regretted that this deposit, apparently so distant from the trap elsewhere intimately associated with these ores, cannot be carefully examined.

d The Cornwall ores are represented by seven samples, two from Big hill, one from Grassy, and three of magnetite and one of copper ore from Middle hill. The latter represents the ore which is picked from the magnetite, in which it occurs in irregular pockets, and sold to smelting-works as it accumulates:

Analyses of Cornwall ores.

e

	1401.	1402.	1405.	1403.	1404.	1406.	1407.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	49.53	50.93	59.74	56.67	44.56	53.80	----------
Phosphorus	0.013	0.017	Trace.	0.011	0.019	0.009	----------
Phosphorus in 100 parts iron	0.026	0.033	----------	0.019	0.043	0.017	----------
Copper (not analyzed for Fe)	----------	----------	----------	----------	----------	----------	11.62

In the neighborhood of Reading, in Berks county, are two mines, opened on ores essentially like that of Cornwall, but in much more disturbed deposits. These are the Fritz Island mine, 1 mile south of Reading, in the Schuylkill, and the Wheatfield mine, 7 miles southwest of Reading.

An attempt is made to indicate the character of the Wheatfield deposit in the accompanying section based on approximate measurement by pacing across five of the seven ore deposits.

f

FIG. 63.—APPROXIMATE SECTION OF PART OF THE WHEATFIELD MINE.
1 TRAP, 2 MAGNETIC ORE AND LIMESTONE, 3 MESOZOIC RED SANDSTONE.

The strike is nearly north and south. The dip is about 40° to the west. Going westward from a low hill on the east one crosses in 300 yards seven outcrops of the Mesozoic red sandstone with the same number of marble- and ore-beds apparently interstratified. The sandstone is metamorphosed to a dense quartzite, which at times resembles the trap. The ore occurs in irregular deposits between the marble and the over and underlying sandstone, and in the marble itself; the latter is formed of angular fragments, readily distinguished by form and coloring from the inclosing matrix of calcite; the whole mass is a breccia.

Professor T. Sterry Hunt, speaking of the association of these magnetic ores with trap-dikes, says (*Transactions American Institute of Mining Engineers*, Vol. IV, p. 323): a

The Dillsburg ores are interposed in granular silicious rocks, and are associated in most cases with eruptive traps, not unlike those of the Cornwall mine—a fact which has served to confirm the popular notion that these ore-deposits are in some way dependent upon the eruptive rock. It is, however, found, in some cases where these traps cut across and interrupt the ore-deposit, that this is continued unchanged on the farther side of the dike, and at Wheatfield, where similar ores are mined, these traps are wanting, although the miners, firm in the conviction that trap-rock is an indispensable condition of a successful mine, maintain that the granular detrital quartzite, with which the ore is here interstratified, is itself a trap.

Undoubtedly the quartzite is not trap; but a body of trap appears to form the eastern boundary of the deposit, and a very distinct dike cuts across the beds with a northeast and southwest course. Specimens from this dike cannot be distinguished from those from Cornwall, Jones', French Creek, Fritz Island, or Dillsburg. b

The Fritz Island mine is worked through an incline, sunk, it is said, 275 feet from the surface in ore. The body thus opened extends about 400 feet eastward under the Schuylkill, and 75 or 100 feet westward from the incline; at both ends it is pinched out by the meeting of the hanging-wall and foot-wall. A small dike of trap runs through the ore, dipping, conformably with it, toward the north, and sometimes expanding so as almost to cut it out. Both walls are formed of a breccia indistinguishable from the marble at Wheatfield, and called by the miners "allsorts". From the western end of this ore-body a drift was driven southward 90 feet into the foot-wall, and a parallel deposit of ore found. This extends eastward from the cross-cut about 80 feet; its western limit has not been reached. The hanging-wall is the "allsorts" that fills the space between the two veins, while the foot-wall is an unbroken dike of trap. c

Two samples were taken from the Wheatfield and Fritz Island mines: One from a car-load of Wheatfield ore on the track, the other from 800 tons of Fritz Island ore at the Reading Iron Works. The analyses are—

	Fritz Island.	Wheatfield.
	1411.	1420.
	Per cent	*Per cent.*
Metallic iron	41.84	37.88
Phosphorus	0.029	0.025
Phosphorus in 100 parts iron	0.069	0.066

d

After the Cornwall the most extensively worked of these deposits are those of Boyertown. There are here four distinct mines—the Phœnix, the California, the Warwick, and the Gable. The two former are worked by the Phœnix Iron Company, of Phœnixville, the third by the Warwick Iron Company, of Pottstown, and the latter by the owners.

I am much indebted to Mr. J. H. Hardin, superintendent for the Phœnix company, for maps and information; to Mr. J. Fegley, superintendent of the Warwick mine, for the very recent map of the workings under his control; and to Captain Polkenhorn, of the same mine, for assistance in making my observations.

The owners of the Gable mine permitted me to go through their workings, but I was unable to plat my observations with the same accuracy as in the other cases.

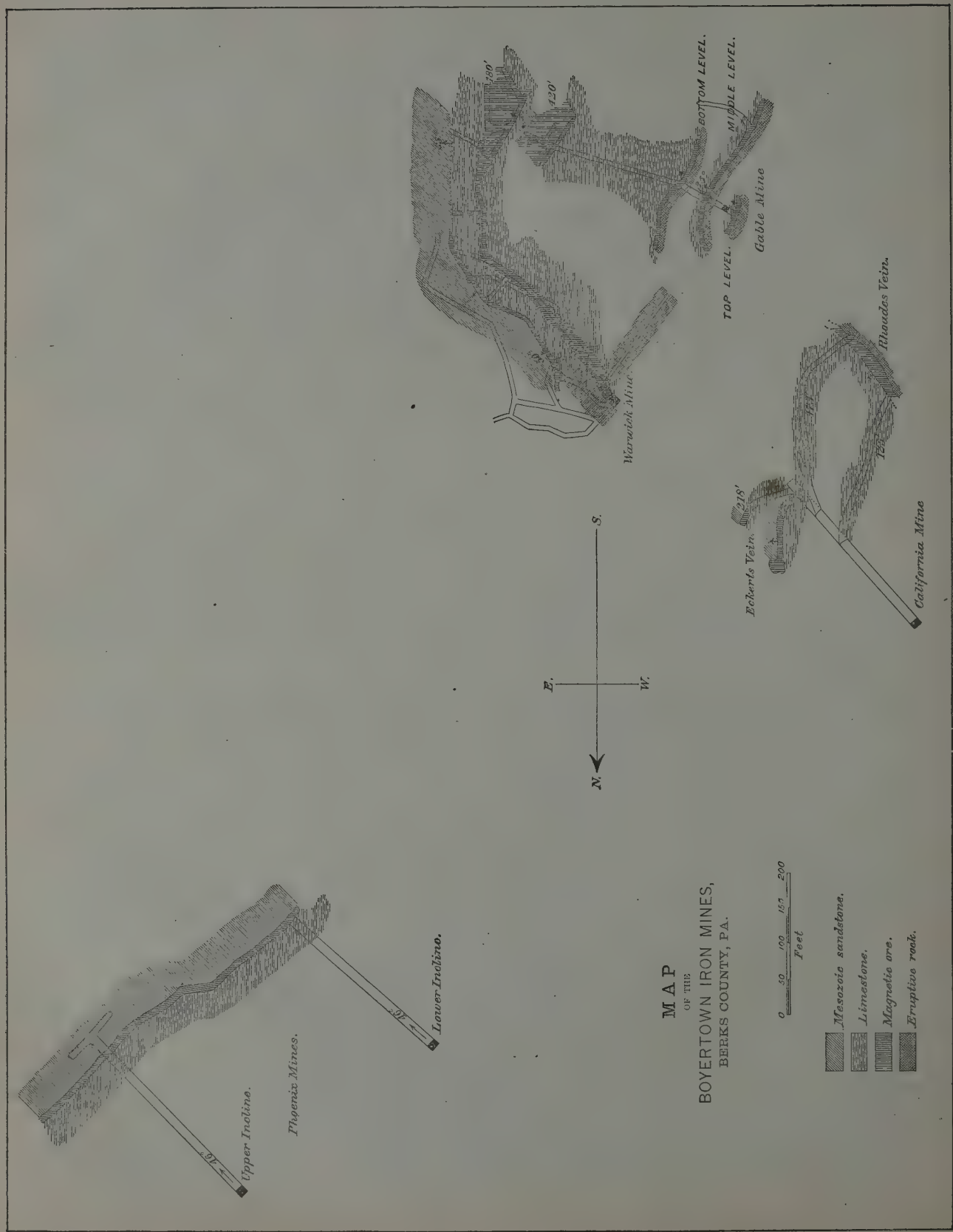
The Phœnix mines present the simplest structure. Two inclines, having an average slope of 46°, are sunk on e the ore, between a hanging-wall of Mesozoic red sandstone and a foot-wall of dark-gray limestone. Drifts, of which only the lowest is shown on the map, have been driven off on either side of the incline, and the ore removed by stoping. The bed varies from 7 to 12 feet in thickness, and near the hanging-wall there is usually a selvage of chloritic slate, which comes down in mining. The strike is quite regular, about northeast and southwest, and the beds have the apparent prospect of continuing indefinitely in either direction; just southwest of the lower incline the bed is pinched out, however, and no exploration has been made to ascertain whether it continues or not.

A shaft, known as Eckert's, and not down on the map, was sunk a short distance northeast of the California incline, and "Eckert's vein" was opened by it. The Phœnix company owns part of the mineral right on this "vein", and the California incline was sunk through rock to develop it and "Rhoades' vein", which was known by surface workings. f

As will be seen from the map, the northeast drifts of the California mine reach the southwest end of Eckert's ore; while two long cross cuts have been driven through limestone to Rhoades' deposit. Eckert's is like the Phœnix in geological relations, but strikes nearly north and south, with a dip to the east.

Rhoades' vein strikes at right-angles to the Phœnix, southeast and northwest, and dips northeast; it has a hanging-wall of limestone and foot-wall of trap, and in this resembles the deposit opened by the Gable shaft; the ores obtained from the two openings are also very similar, and the differences of strike and dip are hardly sufficient in so disturbed a corner to render it improbable that they belong to the same deposit.

The lowest working in the California mine, on Eckert's vein, is 218 feet from the surface at the top of the incline; the dip is about 45° toward the east. This drift is 240 feet from the Warwick shaft, measured on the


Upper Incline.
Phœnix Mines.
Lower Incline.
Warwick Mine
420'
420'
BOTTOM LEVEL.
MIDDLE LEVEL.
TOP LEVEL.
Gable Mine
Rhoades Vein.
Echerts Vein.
218'
California Mine
N.
S.
E.
W.
MAP
OF THE
BOYERTOWN IRON MINES,
BERKS COUNTY, PA.
0 50 100 150 200
Feet
Mesozoic sandstone.
Limestone.
Magnetic ore.
Eruptive rock.

map. Ore was first struck in that shaft at a depth of about 400 feet, probably 425 feet below the top of the **a** California incline.

A dip of 38° to 40° would place a southern extension of Eckert's vein in the position of that cut in the Warwick shaft. It does not follow that the ore-body is continuous from the Warwick workings up to the California drifts. In fact, the trap which lies east of the Warwick shaft, and that penetrated in the long cross-cut toward the Gable mine, render it very improbable that there is an undisturbed body of ore here; but it does seem probable that the Warwick, the Eckert, and perhaps the Phœnix beds, which all have a red sandstone hanging-wall and a limestone foot-wall, are disturbed portions of the same originally-connected bed.

A special map is herewith given of the Warwick mine (Fig. 65)

It is opened in the most disturbed portion of the belt, and the apparent development of two parallel ore-beds, **b** together with the exceptional facilities afforded by the kindness of Captain Polkinhorn, led to careful study of it. In the long drift on the middle level, toward the south, there is a well-defined limestone foot-wall. The hanging-wall of red sandstone is also uninterrupted; but between the two, and especially in the northern end of the mine, the limits of the ore are very ill-defined. The wall is usually mixed limestone and ore, and mining is left off simply when the proportion of ore to limestone becomes too small to pay.

As the owners of the mine use their own product the quality is kept at a high standard.

Where the ore-body turns southward the upper bed of ore approaches the lower bed, and it will probably be found that there is but one extending southeastward, beyond the next turn in the Gable property. The variations in the thickness of the ore-bed and the positions of the associated limestone, red sandstone, and trap are given in **c** the accompanying special map.

Accepting the inference that the Warwick, Eckert, and Phœnix deposits have originally formed parts of one bed, though now disturbed and separated by "pinches", it is difficult to understand how the Gable and Rhoades veins can ever have been part of that bed.

The foot-wall of the Phœnix and the Eckert mines is apparently tilted, but otherwise a little disturbed, and continuous stratum. Away from the trap, which has confused the deposit near the Warwick shaft, the limestone foot-wall is in that mine also well defined. The long cut driven from the Gable bed to the large deposit in the south end of the Warwick mine passes through 175 feet of limestone. The same material lies uninterruptedly between the Eckert and the Rhoades beds. Hence it seems highly probable that there are here two distinct deposits of ore. With this in view, it would be interesting to know the results of exploration north of the Phœnix **d** mines.

Turning to the other similar mines, one finds at Fritz island two beds with 90 feet of limestone between them. But the deposit is so disturbed and the development is so insufficient, that this fact can hardly be accepted as confirmatory evidence. At Wheatfield the ore lies above and below and in the limestone; but that deposit is also too confused to base any judgment on.

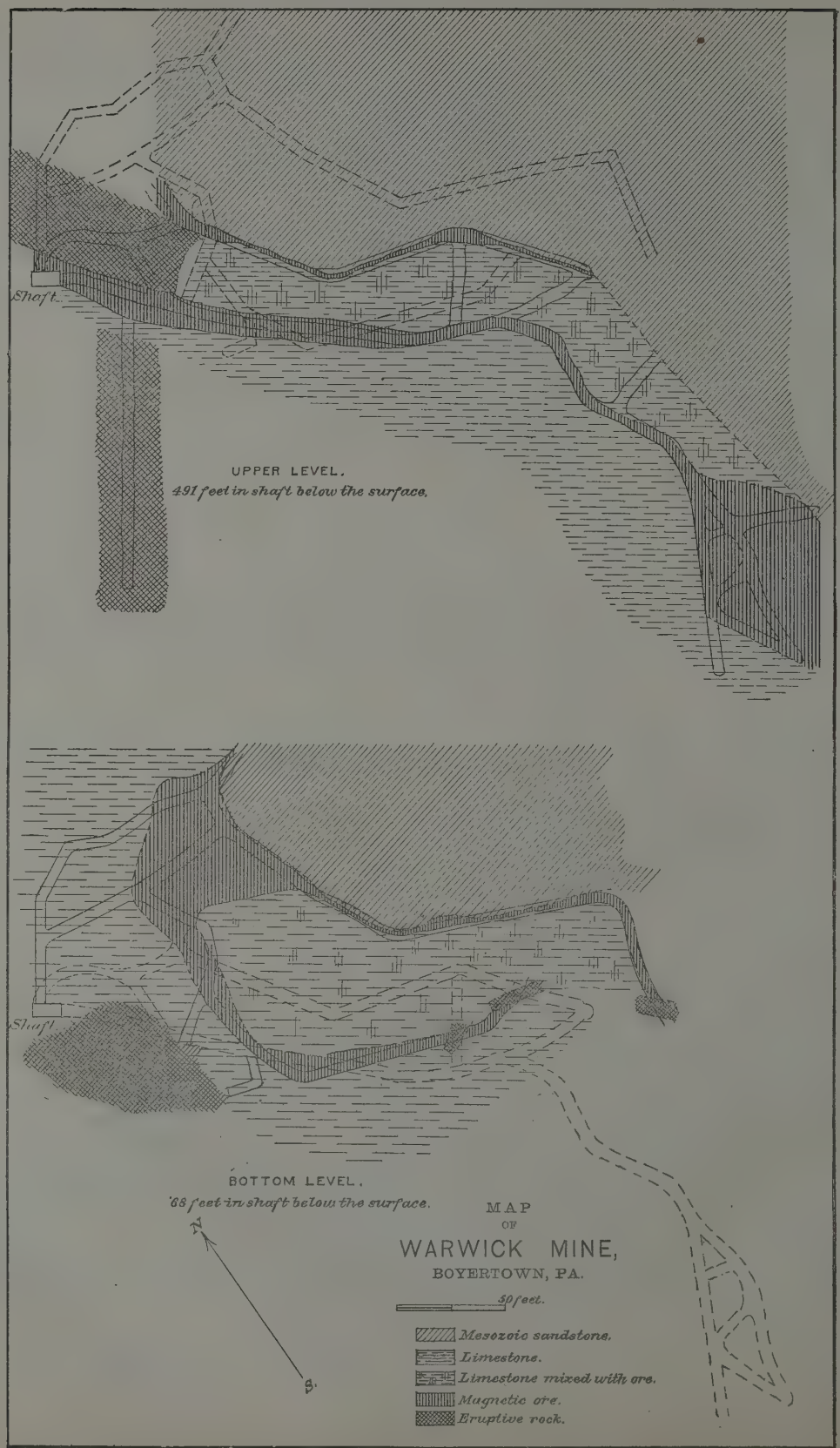
I have already given my opinion, that the limestone at Cornwall was deposited above the ore now to be seen there. If another bed has at any time existed it has apparently been eroded.

At Jones' mine alone do we find the strata above the limestone undisturbed. The light-green shales conformable to it resemble the slates elsewhere interstratified with the ore. It is possible that they represent a stratum here locally so poor in iron that it has all been metamorphosed to a silicate; while at Boyertown the reducing action **e** has resulted in the formation of similar minerals, mingled with magnetic ore.

A very peculiar form of magnetite is not uncommon in the Warwick and Phœnix mines, and occurs frequently in the French creek and Hopewell deposits. This ore has a black streak and is distinctly magnetic, but it is crystallized in thin plates, having the appearance of micaceous specular ore. The immediate inference is that this is a pseudomorph, after specular ore. In Blum's *Nachtrag zu den Pseudomorphosen* (1847, pages 100–102), he describes pseudomorphs of magnetite, after siderite, specular ore, and limonite. In his *Vierter Nachtrag* (1879, pages 11, 12) he mentions two other instances of pseudomorphism of magnetite after specular ore, and says of one specimen: "The pseudomorphs are iron-black, with metallic luster; are magnetic, and have a black streak." The description applies exactly to specimens from Hopewell, French Creek, and Phœnix mines. In the latter several hundred tons of ore of this character were found in a mass. **f**

The occurrence of eruptive rock in the Boyertown mines is shown on the accompanying map; but the great dike, which is exposed for half a mile southwest of Gable's mine in the railroad cuts, is not mapped, as the writer had neither time nor means for a careful survey of the surface-geology.

The trap, which forms the foot-wall of Rhoades and Gable's ores, closely resembles that of Cornwall; but, macroscopically, there is but little similarity between it and the great dike above referred to. The latter is much more coarsely crystalline, and possibly owes its lighter color and different appearance more to that fact than to difference of composition.


Shaft
UPPER LEVEL.
491 feet in shaft below the surface.
Shaft
BOTTOM LEVEL.
68 feet in shaft below the surface.
MAP
OF
WARWICK MINE,
BOYERTOWN, PA.
50 feet.
N.
S.
Mesozoic sandstone.
Limestone.
Limestone mixed with ore.
Magnetic ore.
Eruptive rock.

The ores of the Boyertown mines are represented by six samples: One from Warwick, two from Gable, one a from Phœnix, and two from the California mine.

The analyses are:

	Warwick.	GABLE.		Phœnix.	CALIFORNIA.	
		New vein.	Old vein.		Eckerts.	Rhoades.
	1413.	1414.	1415.	1416.	1417.	1418.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	45.10	47.43	37.73	48.68	54.97	37.57
Phosphorus	0.069	0.038	0.039	0.022	0.037	0.045
Phosphorus in 100 parts iron	0.153	0.080	0.103	0.045	0.067	0.119

b

The Dillsburg magnetites are very similar in many respects to those already described; their chemical composition, associated minerals, and accompanying strata are essentially the same, but they differ in important geologic particulars. The trap which occurs in the mines a mile east of Dillsburg overlies the ore, with sometimes a layer of Mesozoic sandstone between it and the ore-bed; the foot-wall is sometimes limestone, sometimes sandstone. Hence the ores lie apparently more in the Mesozoic sandstone, less distinctly beneath it than elsewhere.

Professor Frazer says of these ores (*Report of Progress, Second Geological Survey of Pennsylvania*, 1877, p. 317):

> That they in their present state belong to the horizon of the Mesozoic series, and to no other, seems to be beyond question; first, because the same variety of that micaceous ore, which is so eminently characteristic of the deposits, can almost always be traced in any c iron-mining locality of this formation from massive plates filling more or less regular interstices between sand-rocks, altered mud-rocks, traps, and shales; to scattered plates of the same ore spread slightly over the inner surfaces of joints and cracks in the sedimentary beds of the above; second, nowhere else is an exactly similar series to be found.

The decision between Professor Rogers and Professor Hunt on the one side, and Professor Frazer on the other, must be decided by those whose thorough acquaintance with all the facts fits them to judge.

Three of the mines east of Dillsburg are represented by samples taken from the ore loaded onto the cars at the depot. The analyses are:

	Bell.	Longnecker.	Underwood.
	1432.	1433.	1434.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	39.55	43.63	44.10
Phosphorus	0.016	0.016	0.018
Phosphorus in 100 parts iron	0.040	0.037	0.041

d

The facts which separate the French Creek and Hopewell mines from all the others examined have already been referred to. The ores are bedded on gneiss; they are not associated with stratified limestone.

The deposit opened in the French Creek No. 1 Shaft is a peculiar formation.

The ore-body measures about 140 feet east and west by 70 feet north and south; the foot-wall, a dark-gray fine-grained gneiss, is nearly vertical; the hanging-wall dips 60° to 70° toward the north, and consists of a fine light-colored granite or gneiss. On the east a vertical wall of trap (?) cuts the ore square off, while on the west a wall of coarsely crystalline marble interrupts it, dipping 50° to the southeast. This marble incloses masses of e granite, and is cut through by dikes of close-grained trap. Half a mile south of the mine a very large dike forms part of a ridge and apparently extends some miles westward.

In Shaft No. 2, within 200 yards of No. 1, a bed of very similar ore but very irregular formation has been developed. The dip here varies from 90° to 30°; at the depth of 150 feet the ore-body is about 120 feet long, and varies very greatly in thickness. The strike is nearly east and west, and the general dip northward, as in No. 1.

It seems probable that these ores have formed part of one bed, that they have been separated in the eruption of the trap, and that the peculiar form of the bed opened in No. 1 is the result of two fissures, the one of which filled with trap (?), the other with crystalline limestone. It should be stated, however, that the limestone of the western wall is coarsely granular, and the crystals are without regular form, while in the ore-mass large well-formed rhombohedra of calcite are very common. If the two have a common origin in crystallization from solution f in thermal waters, which accompanied or followed the eruption of trap, the conditions of formation of the crystals have been essentially different.

Two samples taken from the chutes at the two shafts represent the French Creek ores.

	FRENCH CREEK.	
	No. 1 Shaft.	No. 2 Shaft.
	1421.	1422.
	Per cent.	*Per cent.*
Metallic iron	52.64	56.13
Phosphorus	0.033	0.040
Phosphorus in 100 parts iron	0.083	0.092

a In the neighborhood of Saint Mary's post-office there are a number of old mines from which magnetic ores of the character here described have been obtained for many years. Of these only the Hopewell was working in July, 1881; the Saint Mary's had lain idle for some time, and nothing could be seen of the deposits.

The old Hopewell workings were very extensive, both open-cut and underground; the ore dips 30° to 60° between walls of gneiss, and was followed downward with inclines until a persistent trap dike, which cuts the bed off, dipping in the same direction but with smaller inclination, was met with.

Hopewell Shaft No. 4 was working; this is sunk 150 feet through a coarse-grained gneiss, and the ore-bed has been followed 70 feet on a slope of 30°. The outcrop of the trap lies parallel with the old workings, about 50 yards south of them, the dike and ore both dipping northward.

b Fine specimens of magnetite crystallized in octahedra and of micaceous magnetic ore in arborescent forms were obtained from this mine. The ore as shipped is represented by the following analysis:

	Hopewell Shaft No. 4.
	1423.
	Per cent.
Metallic iron	57.29
Phosphorus	0.030
Phosphorus in 100 parts iron	0.068

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN OHIO.

By Bailey Willis.

The workable iron ores of Ohio all belong to the Lower Coal Measures, and are found in nearly horizontal beds, interstratified with coals, limestones, shales, and sandstones. When unaltered they consist of carbonate of iron, with varying amounts of lime, clay, and sand; they are dark grayish blue, gray, and even white in color, and dense, cryptocrystalline, concretionary, or oölitic in structure.

When exposed to oxidation they form limonites, whose peculiarities of structure present many interesting features; the most common form is that of a rounded mass consisting of concentric layers, often aptly compared to the successive coats of an onion. The chemical change is accompanied by a shrinkage of volume, which accounts for the space found between the layers and the cellular structure of the "honeycomb" or "curly" ores. The ores are found in all stages of this transformation; on the outcrop they are limonite; under heavy cover, carbonate; while between, going from the outcrop inward, the former constantly decreases in proportion to the latter. In the alteration of the more compact carbonates the line of chemical change is usually very sharply defined, and the limonite covering can often be entirely removed from the inclosed core by a blow with a hammer. The oölitic carbonates generally change to a honeycomb ore, and the line of division is less distinctly marked. The original gray carbonate occurs in "kidneys", irregular oval masses, distributed through a bed of shale, and in compact, solid beds. The oxidation of a gray kidney necessarily results in a limonite kidney, while the alteration of a compact bed may result in a cellular limonite or a kidney by the rounding off of the corners, which are most rapidly attacked.

The term "kidney" is thus applied to some of the carbonates and to all the limonites having a concentric structure.

These ores are generally too thin to pay for drifting; hence their use is confined to localities where erosion has so exposed them in the hill-sides as to make them accessible by stripping off the overlying strata. The depth to which this stripping is profitable depends upon the thickness and quality of the ore, and the amount of ore of a given thickness obtained for a given depth of stripping depends upon the slope of the hill.

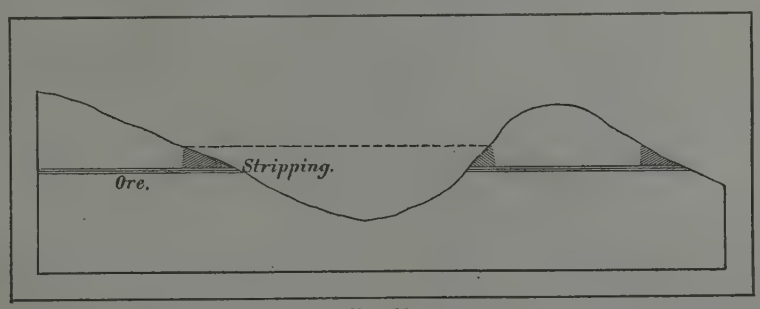
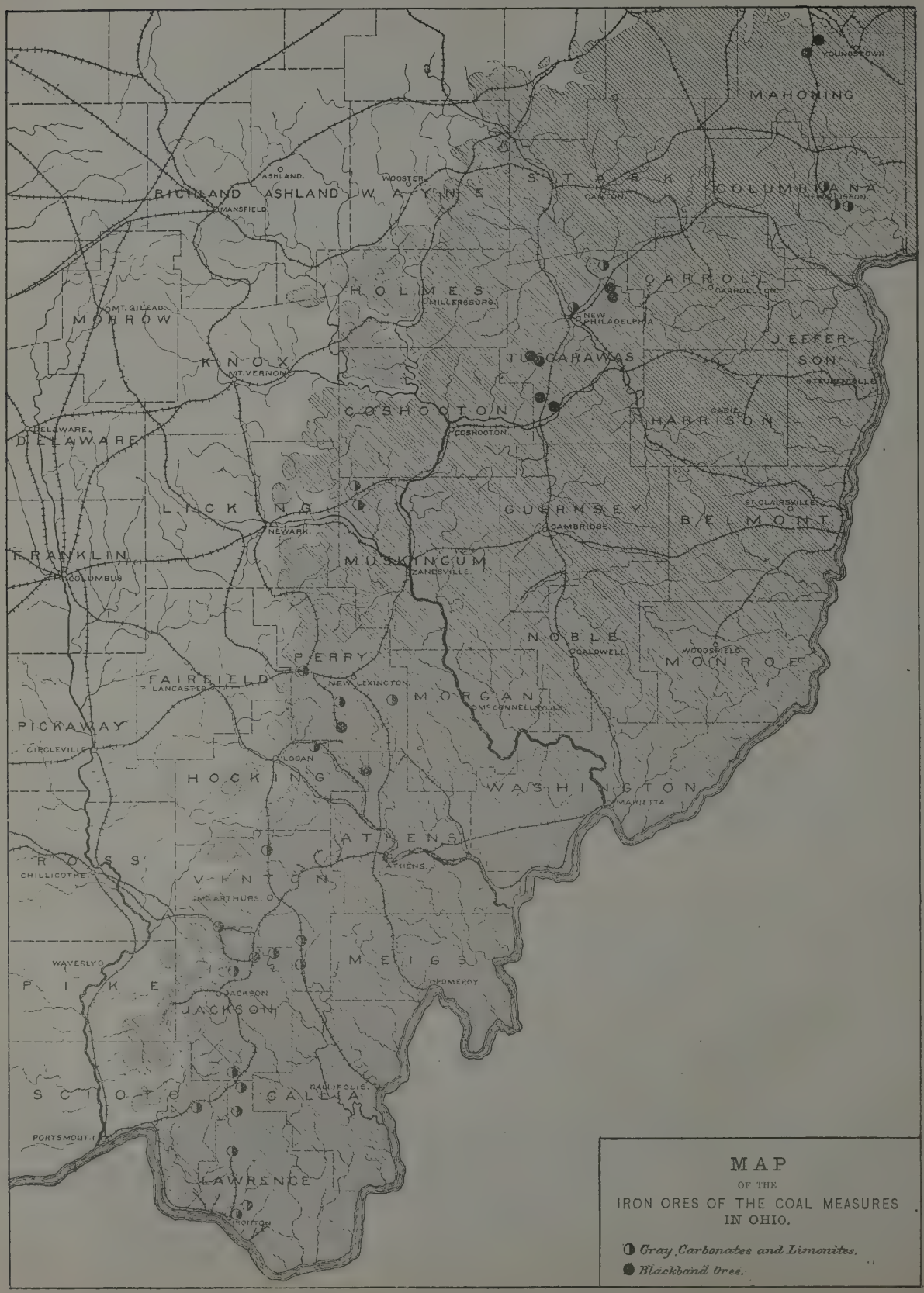


Fig. 66.

The strata are most deeply eroded and the ores are best exposed along the western edge of the Ohio coal-field, and the manufacture of iron from native ores is practically confined to a belt 20 to 30 miles in width, which follows this western limit. In districts where much ore has been taken out, the hills are girdled by a continuous line of such stripping, or, as it is there called, a "bench". As the ore-beds lie so nearly horizontal that the difference of level is perceptible only over long distances, the presence of ore in one hill is proof of the occurrence of a similar bed in any hills of the neighborhood that are high enough to "catch it"; and with the principal deposit of southern Ohio, the "limestone ore", the quality and thickness are so uniform that it can be safely relied upon. This is approximately true of most of the block-ores, though where they occur in the horizon of a limestone they are


MAP
OF THE
IRON ORES OF THE COAL MEASURES
IN OHIO.
Gray Carbonates and Limonites.
Blackband Ores.
YOUNGSTOWN
MAHONING
ASHLAND
WOOSTER
RICHLAND
ASHLAND
WAYNE
STARK
CANTON
COLUMBIANA
NEW LISBON
MANSFIELD
CARROLL
CARROLLTON
HOLMES
MILLERSBURG
NEW PHILADELPHIA
MORROW
MT. GILEAD
KNOX
MT. VERNON
TUSCARAWAS
JEFFERSON
STEUBENVILLE
COSHOCTON
COSHOCTON
HARRISON
CADIZ
DELAWARE
DELAWARE
LICKING
NEWARK
GUERNSEY
CAMBRIDGE
ST. CLAIRSVILLE
BELMONT
FRANKLIN
COLUMBUS
MUSKINGUM
ZANESVILLE
NOBLE
CALDWELL
WOODSFIELD
MONROE
PERRY
NEW LEXINGTON
FAIRFIELD
LANCASTER
MORGAN
McCONNELLSVILLE
PICKAWAY
CIRCLEVILLE
LOGAN
HOCKING
WASHINGTON
MARIETTA
ATHENS
ATHENS
ROSS
CHILLICOTHE
VINTON
McARTHUR
MEIGS
MEDIOMEROY
WAVERLY
PIKE
JACKSON
JACKSON
SCIOTO
GALLIA
GALLIPOLIS
PORTSMOUTH
LAWRENCE
IRONTON

likely to run into it, as shown by Professor Orton. It is not true, however, of the blackbands. The sections given in the description of the ores near Dover, Tuscarawas county, show the rapid changes in thickness of the great blackband of that county, and the exhaustion of the Iron Point ore, the main reliance of the furnaces at Shawnee, shows how unreliable the same ore-horizon is in that region. The investment of capital in the blackband ores, without very careful examination of the deposit by boring, is always hazardous, since ores which may show 5 to 7 feet in thickness at the outcrop may dwindle to a foot in 30 yards.

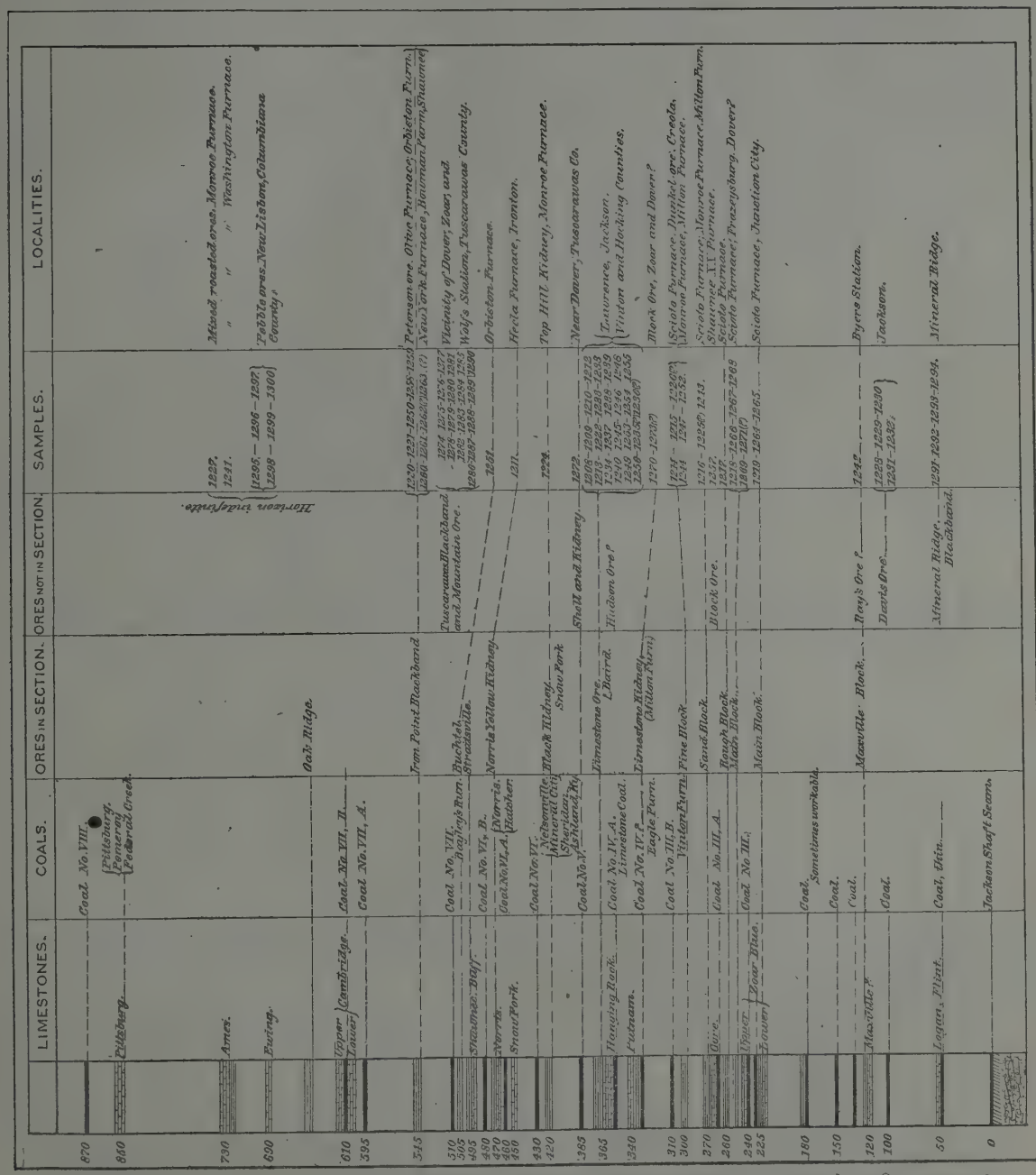


FIG. 68.—GENERAL SECTION OF OHIO COAL MEASURES, SHOWING APPROXIMATE RELATION OF THE IRON ORES SAMPLED.

The accompanying general section is taken from Professor Orton's "Supplemental Report on the Hanging Rock District" (*Ohio Reports*, Vol. III).

In response to inquiries, Professor Orton says: "My general section is for the Hanging Rock district, and will not apply accurately to all portions of the state;" nevertheless, it is used in the accompanying chart to show the approximate relations of the different ores sampled to each other.

a The columns headed "Limestones", "Coals", and "Ores in section" are carefully copied from Professor Orton's section, except that a question-mark is added after the Maxwell limestone, to indicate a doubt he himself expresses in regard to its position. In the column "Ores not in section" are placed those which belong to the northern part of the state, or are too local to have found a place in Professor Orton's classification. The positions of these ores are necessarily only approximate.

A real doubt as to the proper horizon is indicated by a question-mark.

Although this section is thus very general in its present application, it forcibly illustrates the fact that the iron industry of Ohio, so far as native ores are concerned, depends mainly on two horizons and in a lesser degree upon a third, namely, the Tuscarawas and Iron Point blackband, the limestone or Baird ore, and the block ores of the b Zoar limestone horizon.

In the following pages the analyses of the ores will be accompanied by such notes on their peculiarities as may seem of importance.

The lowest ore in the section is the Mineral Ridge blackband. It lies, according to Professor Newberry (*Ohio Reports*, Vol. III, p. 790), about in the position of the Logan flint on Professor Orton's section, and I have therefore added it beneath that coal. The ore is represented by samples from the mine of Tod, Wells & Co., at Mineral Ridge, and the John Henry mine, a mile south of that place.

It occurs at a depth of about 130 feet beneath the surface; the ore has an average thickness of 9 inches, but varies from 5 to 13 inches; it is overlain by about 2½ feet of coal. The ore is dark colored and homogeneous, with c little seams of coal, one-sixteenth to one-fourth inch thick, in the upper layers of the bed. The following are the analyses:

Mineral Ridge blackband.

d

	TOD, WELLS & CO.		JOHN HENRY.	
	Roasted.	Raw.	Raw.	Roasted.
	1291.	1292.	1293.	1294.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	50.62	30.00	30.72	52.52
Phosphorus	0.224	0.150	0.182	0.398
Phosphorus in 100 parts iron	0.443	0.500	0.592	0.758

Two and one-half miles northeast of Jackson, in Jackson county, the Springfield Southern Railroad Company has opened an ore-deposit, which lies just above the "Hill coal". The ore is a dark bluish gray, very compact carbonate; it occurs in five beds, of which the following is the section:

e

Number.	Ore.	Shale.	Coal.
	Inches.	*Inches.*	*Inches.*
5	12		
		1	
4	2		
		4	
3	6		
		12	
2	7		
		14	
1	1½		
			36

This gives 28½ inches of ore in 5 feet; of the five, however, only Nos. 1, 2, and 5 are always found; Nos. 3 and 4 occur in lenticular layers, and above No. 2 there are sometimes little kidneys scattered through the shale. Five samples were taken to represent the five different beds:

f

Davis ore, Lawrence county.

	Bed No. 1.	Bed No. 2.	Bed No. 3.	Bed No. 4.	Bed No. 5.
	1228.	1229.	1230.	1231.	1232.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	35.17	34.07	23.99	32.03	17.97
Phosphorus	0.429	0.270	0.249	0.344	0.216
Phosphorus in 100 parts iron	1.220	0.792	1.040	1.070	1.200

Another ore, mined near Jackson, at Byers station, is locally known as "Ray's ore"; the sample was taken from a car-load of the ore at the Star furnace, at Jackson, and as the deposit was not visited, its place in the

section is uncertain; it may correspond to the Maville block or it may be quite local. The ore is sandy limonite, a with a large number of fossil-plant impressions. The following is the analysis:

Ray's ore, Byers station.

	1242.
	Per cent.
Metallic iron	30.98
Phosphorus	0.377
Phosphorus in 100 parts iron	1.220

b

The "block ores" form one of the important ore-horizons, subordinate only to the limestone and blackband ores. Professor Orton's classification is given in the section; it is here compared with that used at Scioto furnace:

Professor Orton.	Scioto Furnace.
Fine Block	Fine Block. Big Red block.
Sand Block	Little Sand block.
Rough Block	Big Sand block.
Upper Main Block	Little Red block.
Lower Main Block	Flag-ore.

c

The six ores of Scioto furnace are represented by samples taken from a large stock-pile of mixed ores; they each represent a few pieces of ore picked out by the superintendent of the furnace and his workmen, it being impossible for any one not accustomed to the ores to distinguish them from each other; separate piles of each could not be found, as the furnace was not running.

Other more satisfactory samples of block ores were obtained at Monroe furnace, 7 miles north of Scioto, at Milton furnace, near Hamden Junction, at Junction City, and at Frazeysburg. The "Dunkel ore", sampled from five loaded cars at Creola, belongs to this class, and the "Rock ore", dug near Dover, Tuscarawas county, is probably of the same horizon as the upper main block. There is apparently considerable variety in the character of these ores. d

The following are the samples and their analyses:

Scioto Furnace, Scioto county.

	Fine Block.	Big Red.	Little Sand.	Big Sand.	Little Red.	Flag-ore.
	1214.	1215.	1216.	1217.	1218.	1219.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	49.71	40.42	36.19	39.73	39.61	34.43
Phosphorus	0.211	0.579	0.252	0.420	0.515	0.130
Phosphorus in 100 parts iron	0.424	1.430	0.696	1.060	1.300	0.378

e

Block-ores.

	MONROE FURNACE.		MILTON FURNACE.		CREOLA.	JUNCTION CITY.	
	Little Sand (?).	Little Red (?).	Big Sand.	Big Red.	Dunkel ore.	Red.	Kidney.
	1225.	1226.	1243.	1244.	1252.	1264.	1265.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	41.85	42.26	31.56	46.12	41.62	38.73	36.64
Phosphorus	0.320	0.333	0.250	0.197	0.174	0.144	0.102
Phosphorus in 100 parts iron	0.765	0.788	0.792	0.427	0.418	0.372	0.278

f

	SHAWNEE.	FRAZEYSBURG.				JACKSON COUNTY.	DOVER, TUSCARAWAS COUNTY.
	Block-ore.	Goff bank.	McGinnis bank.	Millstead bank.	McDonald bank.	Big Red block, Swaringen farm.	Rock-ore.
	1257.	1266.	1267.	1268.	1269.	1247.	1271
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	44.29	51.86	37.70	32.41	52.17	43.63	39.09
Phosphorus	0.239	0.532	0.281	0.181	0.137	0.665	0.188
Phosphorus in 100 parts iron	0.540	1.026	0.745	0.558	0.263	1.520	0.486

a The Milton furnace "limestone-kidney" lies about 30 feet below the great "limestone bed". No sample of this ore could be obtained near Milton furnace. Another ore, mined near Zoar, Tuscarawas county, apparently belongs to the same horizon, and is so placed on the section. Two samples were obtained of it, one from pieces of ore near pits worked two years ago by the Zoar Society, the other from a stock-pile of about 200 tons at the Tuscarawas furnace, Dover. The analyses are:

b

	ZOAR SOCIETY.	ANMAN FARM, DOVER.
	1270.	1273.
	Per cent.	*Per cent.*
Metallic iron	26.89	34.15
Phosphorus	0.160	0.184
Phosphorus in 100 parts iron	0.595	0.539

The ore is a light-gray carbonate, which forms peculiarly loose shells of limonite in weathering.

The limestone or Baird ore, the most regular and most reliable of the series, is persistent over Lawrence, western Gallia, eastern Jackson, and Vinton, and Hocking counties. It has throughout the same general c characteristics, and is exceedingly uniform in quality. Where unaltered it consists of oölitic grains cemented by clay and silica; near the outcrop it is oxidized to a very porous limonite; it sometimes deteriorates locally to a ferruginous limestone, when it is known as "blue limestone ore". In the southern half of the area of its occurrence the ore-bed consists of two parts—a solid layer, resting on the Hanging Rock limestone, called the "Limestone vein", and rounded masses imbedded in the fire-clay immediately above, called "Limestone kidney". In the northern part of the same area there are no kidneys over the "vein", but a soft red variety appears in the latter, which was not observed farther south. The samples taken represent six varieties of the limonite ore.

Unaltered carbonates:

(1) Gray limestone vein.
(2) Gray limestone kidney.
d (3) Blue limestone ore.

Limonites:

(4) Red limestone vein.
(5) Red limestone kidney.

Hematite:

(6) Soft red limestone vein.

A variety of compact crystalline carbonate, mined near Munroe furnace under the name of "Hudson ore", is considered by Professor Orton to belong to the horizon of the limestone ores. It is certainly a very local deposit; but it was stated to the writer that it rested on the "limestone coal", in which case it would form part of the Hanging Rock limestone. It is placed with the limestone ores.

e

	GRAY LIMESTONE VEIN.			GRAY LIMESTONE KIDNEY.			SOFT RED LIMESTONE VEIN.		BLUE LIMESTONE ORE.	RED HUDSON ORE.
	1234.	1238.	1256.	1209.	1212.	1223.	1246.	1254.	1253.	1235.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	36.56	32.59	34.68	34.27	33.29	43.23	51.97	52.08	35.57	53.82
Phosphorus	0.151	0.211	0.080	0.049	0.144	0.167	0.072	0.112	0.233	0.279
Phosphorus in 100 parts iron	0.413	0.647	0.231	0.143	0.433	0.386	0.139	0.215	0.655	0.518

f

	RED LIMESTONE VEIN.						RED LIMESTONE KIDNEY.			GRAY HUDSON ORE.
	1233.	1237.	1240.	1245.	1248.	1255.	1210.	1222.	1239.	1236.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	47.23	54.89	34.62	51.46	44.34	47.50	41.40	49.32	30.49	23.68
Phosphorus	0.240	0.199	0.074	0.127	0.211	0.205	0.150	0.145	0.156	0.172
Phosphorus in 100 parts iron	0.508	0.363	0.214	0.247	0.476	0.432	0.362	0.294	0.395	0.726

The "shell and kidney ore" of Tuscarawas county, which lies upon coal No. V, the "Snow Fork ore", and the "Norris yellow kidney" are less regular in their occurrence than the block or limestone ores. They are, however, especially the two latter, of considerable local value, on account of their quality. The yellow kidney is used at

Hecla furnace, and the special qualities of the iron, which ranks among the first of the Hanging Rock cold-blast irons, are in part attributed to the mixture of this ore with the limestone. At Monroe furnace the Top Hill kidney or Snow Fork ore is much prized. a

Samples were taken from stock-piles of these ores.

	SHELL AND KIDNEY.	SNOW FORK.	YELLOW KIDNEY.
	1272.	1224.	1211.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	40.65	31.66	32.97
Phosphorus	0.824	0.479	0.317
Phosphorus in 100 parts iron	0.027	1.510	0.961

b

The Buchtel ore occurs in the northern part of Hocking and Athens counties. The thickness of this deposit, "3 to 6 feet," excited great expectations of its value, and the Buchtel furnace, along with several others, was built where this ore is the principal local dependence. These furnaces are now using a large proportion of limestone and Dunkel ore, brought by rail 50 to 70 miles. c

The following is the analysis of a sample carefully taken as an average of 200 tons, at the Orbiston furnace:

	BUCHTEL ORE.
	1251.
	Per cent.
Metallic iron	28.63
Phosphorus	1.450
Phosphorus in 100 parts iron	5.065

d

The level of coal No. VII is an important ore-horizon in Tuscarawas county. Immediately upon the coal lies a bed of blackband, and upon this a layer of more calcareous ore, which sometimes is oölitic in structure, called the mountain ore. The coal varies from

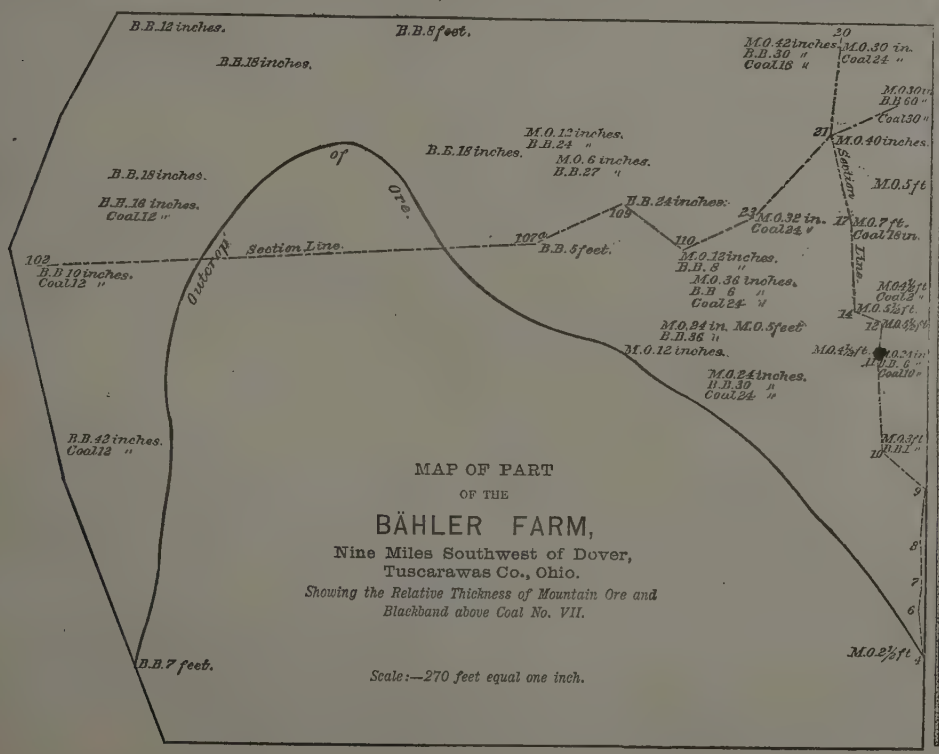


FIG. 69.

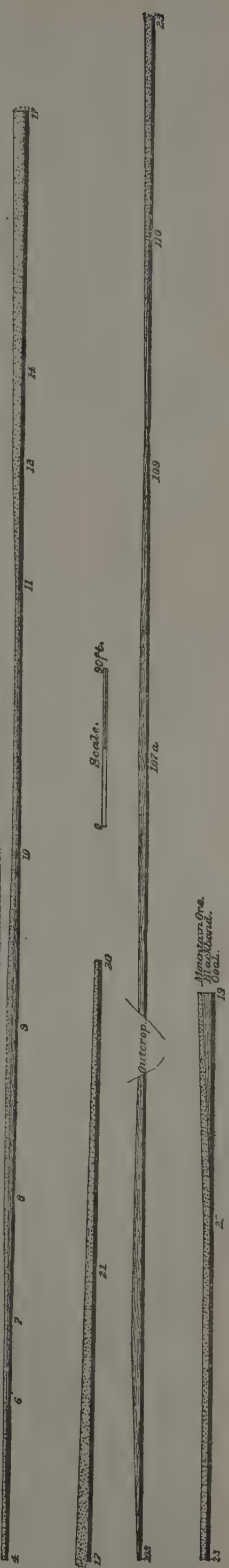


FIG. 70.

a 6 inches to 2½ feet in thickness; the blackband from nothing to 8 feet, and the mountain ore the same. Variations in the thickness of the ores are very sudden. A reference to the accompanying map (Fig. 69) and sections (Fig. 70) of a typical bed on a property that has been thoroughly explored by boring will show the manner of occurrence of these ores. I am indebted to Mr. Croxton, of the Tuscarawas Iron Company at Dover, for the information there given.

Tuscarawas blackband.

b

	GROEBLE FARM.	BÄHLER FARM.					DOVER FURNACE HILL.	
	Mountain ore.	Blackband.	Roasted blackband.	Blackband.	Mountain ore.	Mountain ore.	Blackband.	Roasted blackband.
	1274.	1275.	1276.	1277.	1278.	1279.	1280.	1281.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	32.36	26.31	44.07	27.32	34.68	43.09	23.95	40.91
Phosphorus	0.604	0.195	0.350	0.169	0.705	0.988	0.171	0.422
Phosphorus in 100 parts iron	1.867	0.741	0.794	0.619	2.033	2.293	0.714	1.032

c

	HUGH KELLEY BANK.				WOLF STATION.				
					Dye bank.			Wyan farm.	
	Roasted blackband.	Roasted mountain ore.	Blackband.	Mountain ore.	Blackband.	Roasted blackband.	Blackband.	Blackband.	Roasted blackband.
	1282.	1283.	1284.	1285.	1286.	1287.	1288.	1289.	1290.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	41.12	45.36	27.56	29.52	25.20	42.18	23.90	26.32	44.48
Phosphorus	0.314	0.702	0.159	0.326	0.160	0.264	0.161	0.266	0.312
Phosphorus in 100 parts iron	0.764	1.548	0.577	1.143	0.635	0.626	0.674	1.011	0.701

d

The next ore-horizon above that of Coal No. VII is one which is widely known in the southern counties as the level of the Iron Point blackband; the ore obtained from it varies very greatly in different localities, and the basin, from which it takes its name, Iron Point, near Shawnee, has been entirely exhausted.

The blackband occurs, however, elsewhere near Shawnee, but in much smaller beds and of inferior quality. An ore mined near Moxahala, a gray carbonate, is believed to belong to this horizon. The Orbiston blackband which lies just above the Buchtel ore undoubtedly does, and Professor Orton places the Peterson ore of Olive furnace, Lawrence county, here also. The latter is a peculiar earthy hematite and limonite, quite soft, with thin layers of coal in it, and rests on 18 inches of clean coal.

Ores of the Iron Point blackband horizon.

e

	OLIVE FURNACE.		ORBISTON.	IRON POINT.		BOWMAN FARM.		MOXAHALA.	
	Peterson ore.		Blackband.	Blackband.	Limonite.	Blackband.	Limonite.	Upper beds.	Bottom beds.
	1220.	1221.	1250.	1258.	1259.	1260.	1261.	1262.	1263.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	45.68	46.17	35.08	34.41	46.34	31.96	42.78	34.99	30.23
Phosphorus	0.568	0.652	0.333	0.288	1.132	0.567	0.884	3.106	1.001
Phosphorus in 100 parts iron	1.240	1.410	0.949	0.837	2.443	1.774	2.066	8.877	3.311

f

It remains to describe a very exceptional deposit of ore along the Middle fork of Little Beaver river, Columbiana county. This stream cuts through the Coal Measures from Coal No. VI down to Coal No. III. Within this range there are three beds of gray carbonate ore, too thin to pay for working in place. But along the river-banks the water-worn ore-pebbles are concentrated with 25 to 30 per cent. of granite and quartz drift-pebbles, in beds 8 to 16 feet thick, which lie upon Coal Measure sandstones and shales in place.

The exposed pebbles of gray carbonate become oxidized on the outside, and a brown polished shell of limonite results; this is frequently very loose and fragile, or again dark-colored, resembling a pebble of black quartzite. Where cracks in this shell admit of freer access of air and water to the core the latter is furrowed and often marked like an alligator's skin. The ore is shoveled into riddles, the large pebbles of granite are picked out, and the material remaining is roasted in piles. In a recent contract the Cherry Valley Iron Company specified that the proportion of foreign pebbles must be kept below 10 per cent.

Coal Measure fossils are occasionally found in these beds, and the pebbles themselves often assume very curious shapes. These ores are represented by six samples taken from three workings along the stream near New Lisbon; they are those of Captain B. E. Lewis, William Denman, and A. G. Smith.

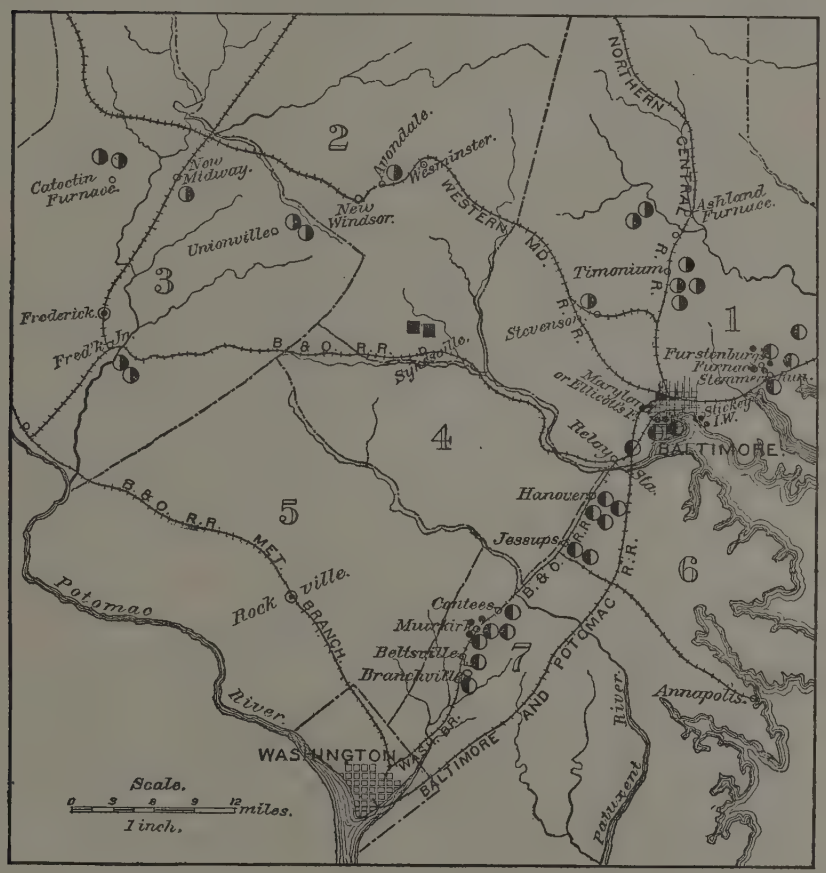
"Kidney" or pebble ores of Middle fork of Little Beaver river.

	CAPTAIN B. F. LEWIS.		WILLIAM DENMAN.		A. G. SMITH.	
	Raw.	Roasted.	Raw.	Roasted.	Raw.	Roasted.
	1295.	1296.	1297.	1298.	1299.	1300.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	38.21	46.07	39.77	48.34	38.04	38.55
Phosphorus	0.516	0.428	0.468	0.468	0.417	0.370
Phosphorus in 100 parts iron	1.351	0.929	1.177	0.968	1.096	0.960

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN MARYLAND.

By Edward R. Benton.

BALTIMORE BELT—MESOZOIC ORES.



1. Baltimore County.
2. Carroll "
3. Frederick "
4. Howard "
5. Montgomery County.
6. Anne Arundel "
7. Prince George "

■ Magnetic ore.
◐ Carbonate ore and its alteration products, i.e. hematite and limonite. (Mesozoic.)
◑ Other limonites.
● Furnace samples.

Fig. 71.—Map of Eastern Maryland, showing location of Iron-Ore banks sampled.

1029. *Jacob Smith's* ore-bank, Baltimore county. Carbonate ore, with hematite and limonite. Working mine situated 11 miles about northeast from Baltimore, and about 1 mile northwest of Jacob Smith's house, on the Philadelphia turnpike.

Considerable ore has been dug at this locality in past years. At least 300 tons were produced in the census year, but the excavations made previous to 1880 are so washed and weathered that little can be learned from them.

a The recent work consists of a drift or tunnel about 40 feet long, inclining downward a few degrees going from the entrance. The mine is entirely in a stiff dark-gray or brownish clay, dipping a few degrees toward the west. The extremity of the drift is about 25 feet below the surface. Above it lie 15 to 20 feet of clay, and above that 5 to 10 feet of sand and sandy loam (see section, Fig. 72).

The ore occurs in the shape of roughly ellipsoidal clay-ironstone nodules, from a few inches to 1 foot or more in longest dimensions, dark red to brown (hematite or limonite) on the exterior. This outer portion is a shell, and consists of several concentric shells, and may be readily broken off, leaving a hard, light-gray lump of argillaceous carbonate of iron or clay-ironstone. These nodules are arranged along certain planes in the clay-bed, and the beds of nodules thus formed have the same dip as the clay-bed.

b

c

d

e

f

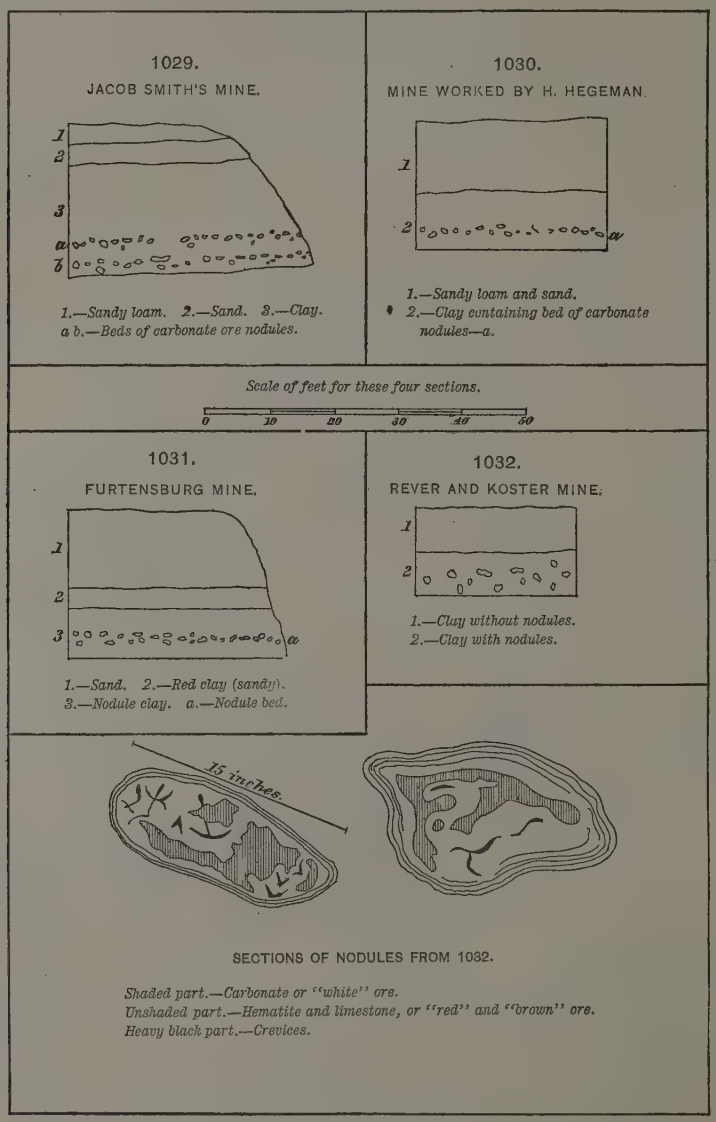


FIG. 72.

Two of these beds of nodules are exposed in section in this mine. In some places the nodules are contiguous, in others there are spaces between them.

Mining here consists merely of digging ahead and taking out whatever nodules are found.

This ore is carted about 4 miles to Furstenburg's furnace, at Stemmer's run, or Rossville; it is then roasted in open piles or in kilns, and used in making car-wheel iron. The mine is owned and worked by Jacob Smith, Rosedale post-office, Baltimore county.

Analysis. a

	1029.	Remarks.
Metallic iron	42.76	Sample taken from two parallel strings of nodules of ore at head of drift. Average thickness of the two strings together, about 1 foot.
Phosphorus	0.092	
Phosphorus in 100 parts iron	0.215	

1030. *Hegeman* or *Smith*, Baltimore county. Carbonate (hematite and limonite). Working mine, open cut, situated on land of Mrs. Henry Smith, about 2 miles east of Furstenburg's furnace, Stemmer's run, just north of Philadelphia, Wilmington, and Baltimore railroad. b

Several acres have been dug over in past years to a depth of 20 to 25 feet, and the nodules of carbonate ore with shells of hematite and limonite have been taken out from the stiff gray clay (see section, Fig. 72). Workings are all open. Mining consists merely of digging away the clay and overlying sand and sandy loam, and picking out the nodules. At least 450 tons were produced in the census year. These ore-nodules are entirely similar in appearance and structure to those of 1029. The nodules have a rather smaller average size. This ore is carted 2½ miles, to Furstenburg's furnace (Stemmer's run), and after roasting is used for making car-wheel iron.

Analysis. c

	1030.	Remarks.
Metallic iron	46.23	Sample taken from pile of several hundred tons of carbonate nodules at the mine.
Phosphorus	0.127	
Phosphorus in 100 parts iron	0.275	

1031. *Furstenburg*, Baltimore county. Carbonate. Working mine, open cut. Just south of Stemmer's Run station, on the Philadelphia, Wilmington, and Baltimore railroad, on land belonging to Levi Furstenburg.

This ore occurs in a horizontal bed of clay, and in the shape of nodules, thus resembling 1029 and 1030, but, unlike them, the nodules have no shells of hematite and limonite, but are composed entirely of the argillaceous carbonate. As a rule the nodules lie with their longer axes horizontal, though not invariably so. A thickness d of about 8 feet of the clay-bed is exposed, and over it lies a 3-foot bed of red sandy clay, which again is overlaid by 12 feet of sand, with a slight amount of sandy clay at the top (see section, Fig. 72). The ore is carted about one-third mile to Furstenburg's furnace, and used, after roasting, for making car-wheel iron.

Analysis.

	1031.	Remarks.
Metallic iron	35.75	Sample taken from a pile of several tons of nodules of carbonate ore at the mine.
Phosphorus	0.098	
Phosphorus in 100 parts iron	0.274	

e

1032. *Rever & Coster*, Baltimore county. Carbonate (hematite and limonite). Working open cut. Land of L. Furstenburg, about 1 mile northeast of Furstenburg's furnace. Worked by Rever & Coster.

The nodules in this excavation, though similar in mineral characters to 1029 and 1030, are much larger, some being 2 to 3 feet in longest dimension. They are not confined to so narrow a bed as the others, but are scattered through a bed of clay 5 to 6 feet thick, above which is 7 to 8 feet of clay entirely without nodules, but otherwise similar to that below (see section, Fig. 72). Sections of some of the larger nodules are exposed in the face of the excavation, and two of these are figured. The ore is carted 1 mile, to Furstenburg's furnace, and roasted to supply the furnace. It makes car-wheel iron.

Analysis. f

	1032.	Remarks.
Metallic iron	40.58	Sample taken from pile of nodules at the mine.
Phosphorus	0.094	
Phosphorus in 100 parts iron	0.232	

1033. Furnace sample, *Furstenburg's furnace*, Stemmer's run, Baltimore county. Carbonate or white.

This sample represents the carbonate portion of the ore received at Furstenburg's furnace from Furstenburg, Jacob Smith's, Hegeman's, Rever & Coster's, and other banks.

a

Analysis.

	1033.	Remarks.
Metallic iron	36.56	Sample taken from a pile of about 500 tons of raw ore at Furstenburg's furnace.
Phosphorus	0.068	
Phosphorus in 100 parts iron	0.186	

1034. Furnace sample, *Furstenburg's furnace*, Stemmer's run, Baltimore county. Hematite and limonite.

For this sample the hematite and limonite or decarbonized portions were selected from the same pile from which sample 1033 was taken.

b

Analysis.

	1034.
Metallic iron	46.17
Phosphorus	0.113
Phosphorus in 100 parts iron	0.245

1035. Furnace sample, *Furstenburg's furnace*, Stemmer's run, Baltimore county. Carbonate (hematite and limonite).

This is the best average commercial sample of the carbonate ore, and its alteration products from the "Baltimore
c belt", northeast of that city.

Analysis.

	1035.	Remarks.
Metallic iron	42.01	Sample taken from pile of 500 tons of raw ore at furnace (same pile as 1033 and 1034). All varieties of ore in the pile were sampled together.
Phosphorus	0.089	
Phosphorus in 100 parts iron	0.212	

1036. Furnace sample, *Furstenburg's furnace*, Stemmer's run, Baltimore county. Roasted ore.

Product obtained by roasting 1035. This gives an average sample of the ore of the "Baltimore belt" northeast
d of the city ready for the furnace.

Analysis.

	1036.
Metallic iron	47.73
Phosphorus	0.079
Phosphorus in 100 parts iron	0.166

1037. *George L. Skaggs*, Prince George county. Carbonate (hematite and limonite). On land of George L. Skaggs,
e 200 yards southeast of Branchville station, Baltimore and Ohio railroad.

The ore here is entirely nodular, and as in case of previous samples, the nodules lie along certain layers in stiff clay. The section (1037, on Fig. 73) illustrates the structure more in detail. There is every grade, from nodules composed wholly of carbonate ore to those wholly decarbonized, and composed of hematite and limonite. This gradation takes place from the bottom toward the top of the section.

An excavation about 120 feet long, 75 feet wide, and 10 to 11 feet deep has been made. It takes five men and two one-horse carts about a week to dig 50 tons and get it loaded on cars at the railroad, 200 yards distant. The ore goes to Baltimore furnaces.

The position of the layers which the hand-specimens 1037*a* and 1037*b* represent is indicated by the letters *a* and *b* on the section.

f

Analysis.

	1037.	Remarks.
Metallic iron	40.85	Sample taken from car-load of 20 tons at Branchville station, Baltimore and Ohio railroad.
Phosphorus	0.060	
Phosphorus in 100 parts iron	0.147	

1038. *George Yokel's.* Carbonate and hematite. George Yokel's land, about 1¼ miles east of Beltsville station, Prince George county, on the Baltimore and Ohio railroad.

Very large excavations have been made here, but weathering has obscured them so much that the structure cannot be seen except that the rock to a depth of 50 feet is composed of clay in beds of various colors.

The mine is worked at present on a very small scale at one end of the old workings. Here the depth reached is not over 15 feet, and the mode of occurrence of the nodules is similar to that of 1037, except that scarcely any

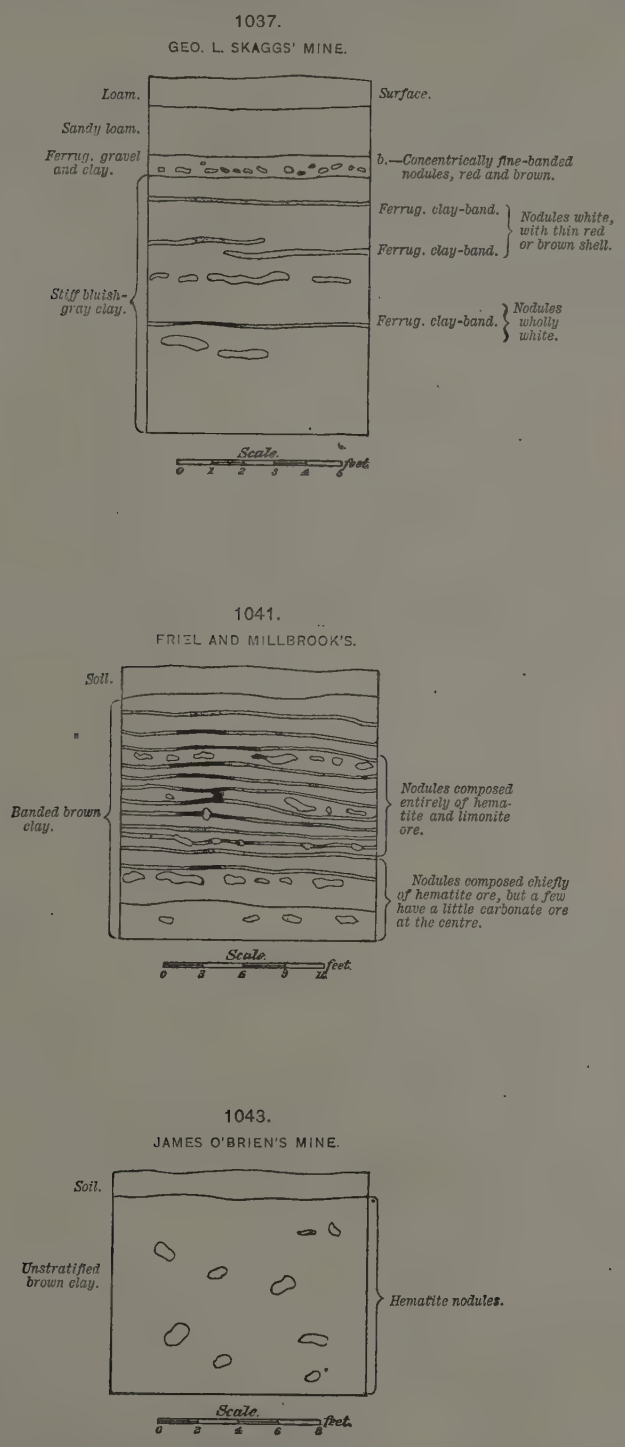


FIG. 73.

wholly carbonate nodules are to be found. The nodules are much fissured, and their decomposition has gone to a much greater depth than in 1037. The alteration has gone on with reference to fissures and crevices in the nodules rather than concentrically.

a The ore is carted $1\frac{3}{4}$ miles to Beltsville station, and shipped to Baltimore. At least 700 tons were shipped from this mine in the census year.

Analysis.

	1038.	Remarks.
Metallic iron	46.51	Sample taken from pile of about 10 tons of nodules at the mine.
Phosphorus	0.115	
Phosphorus in 100 parts iron	0.247	

b

1039. Furnace sample, *Muirkirk furnace*, Prince George county. Carbonate (hematite and limonite). Three mines near Muirkirk furnace.

This sample represents the average quality, before roasting, of the ore used to supply Muirkirk furnace, Muirkirk station, Baltimore and Ohio railroad. The ore is a mixture of carbonate with its alteration products, hematite and limonite. It is from three banks situated $1\frac{1}{4}$ to $1\frac{1}{2}$ miles southeast of Muirkirk station, *i. e.*, Friel & Millhook's, Smith's, and Wood's.

Analysis.

c

	1039.	Remarks.
Metallic iron	42.91	Sample taken from pile of about 1,000 tons at Muirkirk furnace.
Phosphorus	0.073	
Phosphorus in 100 parts iron	0.170	

1040. Furnace sample, *Muirkirk furnace.* Roasted ore.

This sample gives the average character of the product obtained by roasting 1039, and thus represents the ore as it goes into the furnace where it is made into car-wheel iron.

d

Analysis.

	1040.
Metallic iron	46.25
Phosphorus	0.108
Phosphorus in 100 parts iron	0.234

1041. *Friel & Millbrook.* Hematite (with some limonite). Situated $1\frac{1}{4}$ miles southeast of Muirkirk furnace, Prince George county, on land leased by C. E. Coffin, proprietor, Muirkirk furnace. Worked by Pat Friel and Carl Millhook.

e

At least 800 tons of ore were produced in the census year.

A circular excavation covering about 1 acre has been made. The depth reached is 20 feet, and all the rock exposed is stiff, dark-brown or gray clay, with the exception of 1 to 2 feet of soil.

The section on Fig. 73 show the general distribution of the nodules. The clay in this bank shows more perfect marks of stratification than is usual. These marks consist of five bands of reddish-brown clay. The ore, except near the bottom of the pit, is all hematite with a little limonite. Near the bottom a few of the nodules have cores of carbonate ore. The amount of strictly white ore in the sample is inconsiderable. This ore is carted $1\frac{1}{4}$ miles to Muirkirk furnace, and goes in with other red ores and with some white ores which, after roasting, are used in the furnace for making car-wheels, boiler-plates, and ordnance iron.

f

Analysis.

	1041.	Remarks.
Metallic iron	43.25	Sample taken from pile of 5 tons at Muirkirk furnace; 2 tons on carts and 3 tons at the ore-banks.
Phosphorus	0.101	
Phosphorus in 100 parts iron	0.233	

1042. Furnace sample, *Muirkirk furnace.* White or carbonate.

This sample gives the average quality of the white or argillaceous carbonate portion of the raw ore supplied to the furnace by Friel & Millbrook's, Donaldson's, and Wood's banks, all near the furnace.

Analysis. a

	1042.	Remarks.
Metallic iron	41.07	Sample taken by selecting the white or strictly carbonate portions of the nodules contained in a pile of about 1,000 tons at Muirkirk furnace.
Phosphorus	0.060	
Phosphorus in 100 parts iron	0.146	

1043. *James O'Brien.* Hematite, with a little carbonate. Mine situated one-quarter of a mile south of Contee's station, Baltimore and Ohio railroad, on James O'Brien's land, Prince George county.

There are several acres of old workings here, but the work is now carried on upon quite a small scale. In one b spot there is a fresh face 12 feet in height exposed, the structure of which is shown in the section, Fig. 73.

The nodules are not arranged, as a rule, along definite lines, and the clay is unstratified. The nodules are composed almost entirely of hematite, though some carbonate ore occurs near the bottom. This mine produced at least 800 tons in the census year. The ore is shipped at Contee's station, on the Baltimore and Ohio railroad, to Baltimore.

Analysis.

	1043.	Remarks.
Metallic iron	45.57	Sample taken from 30 tons of nodules at the mine and 40 tons at Contee's station.
Phosphorus	0.090	
Phosphorus in 100 parts iron	0.197	

c

1044. *A. S. Linthicum.* Hematite, with small amount of carbonate. Two open cuts, 1 mile south of Jessup's station, Baltimore and Ohio railroad, on land of Dr. A. S. Linthicum.

Two excavations at this bank, the one circular, with a diameter of 150 feet and a depth of 25 feet; the other is 285 feet long, 80 to 100 feet wide, and 20 to 30 feet deep. The structure in both is similar to that of 1043. Here most of the nodules are composed of hematite, but a few at the bottom are, in part, carbonate ore. This latter was sampled separately (see No. 1045). This mine produced at least 2,200 tons in the census year. The ore is shipped at Jessup's station to Baltimore.

Analysis. d

	1044.	Remarks.
Metallic iron	46.79	Sample taken from about 50 tons of nodules at the mine.
Phosphorus	0.150	
Phosphorus in 100 parts iron	0.321	

1045. *A. S. Linthicum.* Carbonate. Same mine as 1044.

The carbonate ore contained in the lowest 6 feet of the mine was sampled separately, though it is not kept separate for shipment.

Analysis. e

	1045.	Remarks.
Metallic iron	37.60	Sampled from about 20 tons of nodules at the mine. From lowest 6 feet.
Phosphorus	0.066	
Phosphorus in 100 parts iron	0.176	

1046. *Mitchell, Wilson & Riley.* Carbonate. Open cut, one-quarter of a mile southeast of Hanover station, Baltimore and Ohio railroad, on Howard Brown's land, Anne Arundel county.

A cut 600 feet long, 100 feet wide, and 20 to 50 feet deep has been made, running east and west. A thickness of 5 to 8 feet at the top is soil, sand, and gravel; below this is 5 to 15 feet of light-brown, somewhat silicious clay, f containing nodules of carbonate ore, of the same color as the clay, and also somewhat silicious; below that is a dark-gray plastic clay, containing nodules of white or very light-gray carbonate ore, of very fine texture, without the silicious appearance of the nodules in the upper part. These lowest nodules are the ones represented by this sample (*i. e.*, 1046), represented on Fig. 74.

Analysis.

	1046.	Remarks.
Metallic iron	37.87	Sample taken from 25 tons of nodules at the mine. These came from the dark-gray plastic clay forming the lower part of the exposure.
Phosphorus	0.063	
Phosphorus in 100 parts iron	0.166	

a 1047. *Mitchell, Wilson & Riley.* Carbonate. Same as mine 1046.

This sample represents the somewhat silicious nodules which come from the light-brown silicious clay in the upper part of the exposure.

Analysis.

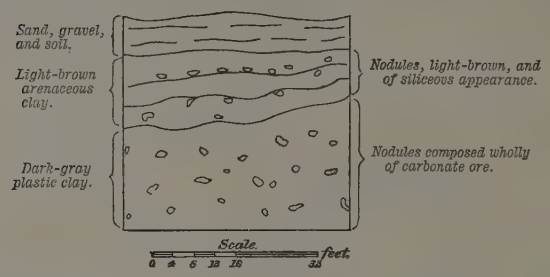
b

	1047.	Remarks.
Metallic iron	36.17	Sampled from 25 tons of nodules at the mine.
Phosphorus	0.049	
Phosphorus in 100 parts iron	0.135	

c

1046.

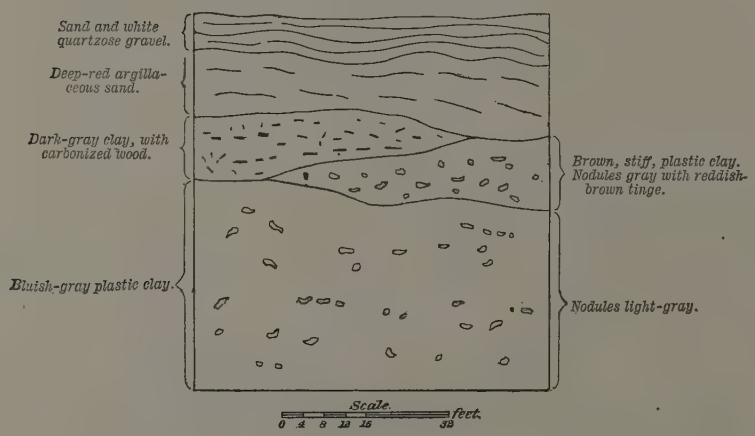
MINE OPERATED BY MITCHELL, WILSON AND RILEY.



d

1048.

MINE OPERATED BY REYNOLDS, KYNE AND ARNOLD.



e

1050.

JACOB ODENSOSS' MINE.

f

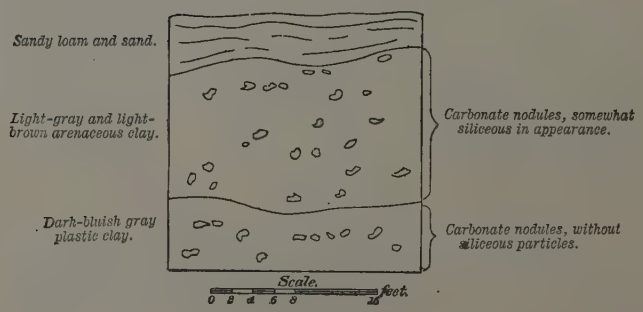


FIG. 74.

1048. *Reynolds, Kyne & Arnold.* Carbonate. Open cut, one-half mile southeast from Hanover station, Baltimore and Ohio railroad, on Howard Brown's land, Anne Arundel county. a

An excavation 500 feet long, 200 feet wide, and 50 to 75 feet deep has been made in the west side of the hill, longest from north to south.

The proportional thicknesses of the different beds vary greatly in different parts of the mine, some beds being *wanting* in some parts, others in others—(1) at the top is a thickness of 5 to 10 feet of yellowish sand and yellow and white quartz-gravel, below which are found beds of (2) red, somewhat sandy clay, in thickness 5 to 10 feet; (3) below the red bed is (in some parts of the excavation) dark-red clay, with sticks and lumps of charcoal imbedded in it; thickness, 0 to 12 feet; (4) next below this comes brown, stiff, plastic clay, with impure carbonate nodules having a reddish-brown tinge; these are represented in sample 1049; (5) below the brown clay, and forming the b deepest material yet reached, is bluish-gray plastic clay, with nodules of carbonate ore of a light-gray color, very fine-grained, and often with a highly conchoidal fracture; these are represented by sample 1048. This bed forms the lowest 15 to 30 feet of thickness (see section, Fig. 74).

Analysis.

	1048.	Remarks.
Metallic iron	38.48	Sample taken from about 60 tons of nodules at the mine.
Phosphorus	0.025	
Phosphorus in 100 parts iron	0.065	

c

1049. *Reynolds, Kyne & Arnold.* Carbonate. Same mine as 1048.

This sample represents the slightly reddish-brown carbonate nodules from the brown plastic clay of the upper nodules bearing bed.

Analysis.

	1049.	Remarks.
Metallic iron	36.10	Sample taken from a pile of about 40 tons of nodules at the mine.
Phosphorus	0.040	
Phosphorus in 100 parts iron	0.111	

d

1050. *Jacob Odensoss.* Carbonate. Open cut, 4 miles southwest of Baltimore, on land of Jacob Odensoss, one-half mile northwest of Washington road, Baltimore county.

A circular excavation has been made 125 feet in diameter and 25 feet deep (see section, Fig. 74).

Analysis.

	1050.	Remarks.
Metallic iron	37.53	Sample taken from about 20 tons of nodules at the mine.
Phosphorus	0.041	
Phosphorus in 100 parts iron	0.109	

e

1051. *Norris* or *Whitaker.* Hematite, with some carbonate. Mine situated 2½ miles south of Baltimore, on the Annapolis road, Baltimore county.

The old workings cover several acres. The banks have suffered so much weathering that it can only be seen that the chief material is a brown clay. There are two recent excavations of small size, and in these the brown clay contains nodules of hematite to a depth of 8 to 12 feet. Below that they contain, at the center, carbonate ore of a f coarse texture and having a reddish tinge. The mine belongs to George P. Whitaker, and the ore goes to his Principio furnace, at Principio, Cecil county, Maryland.

Analysis.

	1051.	Remarks.
Metallic iron	40.73	Sample taken from 30 tons of nodules at the mine.
Phosphorus	0.149	
Phosphorus in 100 parts iron	0.366	

a 1052. Furnace sample, *Stickney Iron Company's Furnace*, Baltimore. Carbonate. Ore from Spring Garden, Hanover, Jessups, Contees, and many small producers in Prince George and Anne Arundel counties.

This ore came chiefly from the above localities—from the mines which samples 1024, 1043, 1044, 1045, 1046, 1047, 1048, and 1049 represent. The object of taking this sample was to obtain the average quality of strictly "carbonate" ore of the Baltimore belt southwest of the city.

Analysis.

b

	1052.	Remarks.
Metallic iron	37.94	Sample taken from piles containing 3,000 tons of ore at Stickney Iron Company's furnace.
Phosphorus	0.055	
Phosphorus in 100 parts iron	0.145	

1053. Furnace sample, *Stickney Iron Company's Furnace.* Hematite, with small amount of limonite. Same pile ore as 1052.

Average sample of the non-carbonate portions of the nodular ore from the "Baltimore belt" southwest of the city.

c

Analysis.

	1053.	Remarks.
Metallic iron	44.41	Sample taken by selecting the hematite and limonite portions of the nodules in piles containing 3,000 tons.
Phosphorus	0.177	
Phosphorus in 100 parts iron	0.399	

1054. Furnace sample, *Maryland* or *Ellicott's Furnace*, Baltimore. Carbonate (hematite and limonite). Ore from Beltsville, Contees, Jessups, Hanover, and many small producers in Baltimore county.

d This sample gives the average quality of the carbonate ore with its alteration products for the whole of the Baltimore belt southwest of the city. The furnace obtained ore from over 200 small producers in Baltimore county, as well as from many small producers in Prince George and Anne Arundel counties.

Analysis.

	1054.	Remarks.
Metallic iron	40.87	Sample taken from pile of several thousand tons of nodular ore at Ellicott's furnace, Baltimore.
Phosphorus	0.073	
Phosphorus in 100 parts iron	0.179	

e 1055. Furnace sample, *Maryland* or *Ellicott's Furnace*, Baltimore. Roasted ore. From same localities as 1054.

Analysis.

	1055.	Remarks.
Metallic iron	45.84	This sample represents the product obtained by roasting in kilns the ore represented by sample 1054.
Phosphorus	0.123	
Phosphorus in 100 parts iron	0.268	

f

ORES FROM OTHER HORIZONS THAN THE MESOZOIC.

1056. *Ridgeley.* Limonite (lump). Open cut, situated on John Ridgeley's land, 8 miles north of Baltimore and one-half mile east of York road, Baltimore county.

Only a small excavation has been made at this mine, 50 feet long, 20 feet wide, by 20 feet deep. This and other small excavations on Ridgeley's land, which are now abandoned and washed in, produced 500 tons of ore in the census year. The ore in this mine is limonite, in lumps and fragments usually more or less angular, and disseminated irregularly through the clay. There is no solid bed or body of ore. The upper 3 feet of thickness here consists of red, yellow, and white clayey and gravelly strata. Below the material is a brown unstratified sandy clay, containing the ore in irregularly-distributed fragments and flat masses, some of which are 2 feet in largest dimensions. This ore is carted 2½ miles, to Timonium station, on the Northern Central railroad, and shipped to Ashland furnace, 4 miles to the north, where it is used with other ores for making foundery iron.

Analysis. a

	1056.	Remarks.
Metallic iron	54.42	Sample taken from pile of lump-ore containing 10 tons at the mine.
Phosphorus	0.200	
Phosphorus in 100 parts iron	0.368	

1057. *Woods.* Limonite (washed). Open cut, situated 9 miles north of Baltimore, and three-fourths of a mile east of York road, Baltimore county.

Here, close to the steam-washer, two excavations have been made, one being 100 feet long, 50 feet wide, and b 35 feet deep, the other 60 feet square and 40 feet deep. The ore is limonite, in lumps and bunches of irregular shape and distribution. The upper 10 to 5 feet of the material in these excavations consists of stratified mixtures of sand, clay, and gravel, while below is a heavy brown clay, mingled in places with argillaceous sand. Here and there irregularly horizontal sheets of ore, an inch or two thick and a few feet in extent, are found, in other places similar sheets occur variously inclined, but in general there is no regularity to be observed.

Mining could not be carried on with any chance of profit, were it not that all the ore-bearing parts of the material are put through the washer. It is sometimes the case that not more than one-tenth of the material washed is ore.

About 500 tons of ore were sent from this mine to Ashland furnace during the census year. The ore is carted c 2 miles, to Timonium station, and thence shipped on the Northern Central railroad to the furnace.

Analysis.

	1057.	Remarks.
Metallic iron	40.39	Sample taken from pile containing 50 tons of washed ore at washer close to mine.
Phosphorus	0.102	
Phosphorus in 100 parts iron	0.253	

1058. *Talbot.* Limonite (lump). Open cut, situated 9 miles north of Baltimore and three-fourths of a mile north d of York road, Baltimore county, just southwest of the Woods mine washer.

An excavation has been made here 75 feet long, 25 feet wide, and 30 feet deep. The ore is limonite. Larger bunches of ore were seen here than in the Woods or the Ridgeley mines. It is said that there is a continuous layer of ore at the bottom 3 feet thick, but the mine was not in operation when visited, and this was not to be seen. All the washed ore had been carted away, so it was necessary to take the sample from a pile of lump-ore. The structure is essentially the same as that of the Woods mine. Ore goes to Ashland furnace.

Analysis.

	1058.	Remarks.
Metallic iron	52.72	Sample from pile of 40 tons of lump-ore at the mine.
Phosphorus	0.067	
Phosphorus in 100 parts iron	0.127	

e

1059. *Kelly.* Limonite (washed). Open cut, 10 miles north of Baltimore and one-half mile east of York road, Baltimore county.

Here an excavation 275 feet long, 190 feet wide, and 60 feet deep has been made, running northeast and southwest. Four thousand two hundred tons of ore were sent from this mine to Ashland furnace during the census year. The ore is limonite in small fragments of irregular distribution. Here and there a regular structure exists, and an instance of it is shown by the section (Fig. 75). Very little lump-ore is obtained. The material is f nearly all washed at the mine by a steam-washer. The ore is carted 2 miles to Timonium station, and goes thence 4 miles on Northern Central railroad to Ashland furnace.

Analysis.

	1059.	Remarks.
Metallic iron	38.96	Sample taken from pile containing about 100 tons of washed ore at the washer, close to the mine.
Phosphorus	0.174	
Phosphorus in 100 parts iron	0.447	

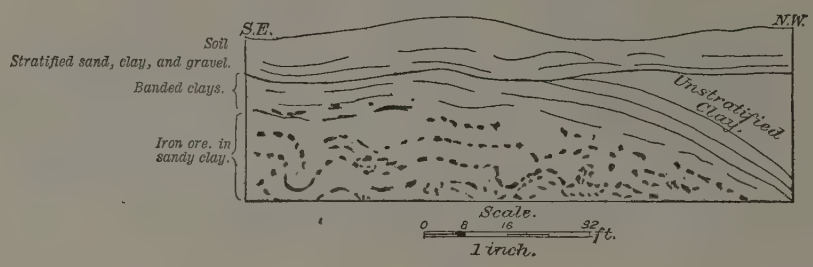
a 1060. *Oregon.* Limonite (washed). Open cut, 3 miles west of Ashland furnace, Baltimore county.

Here an excavation running east and west, 1,200 feet long, 200 feet wide, and 80 feet deep, has been made. Five thousand tons of ore were shipped to Ashland furnace during the census year. The ore is limonite in fragments, *i. e.*, no solid continuous body of ore is to be observed. All or nearly all the ore-bearing material must be washed, and this is done by a steam-washer at the mine. Most of the ore occurs in sandy clay, as in the several

1059.

KELLY'S MINE.—SECTION ACROSS SOUTHWEST END.

b



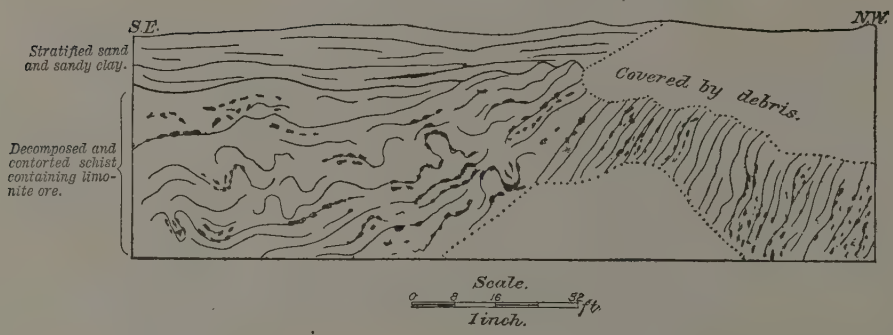
c

1060.

OREGON MINE.—SECTION ACROSS WEST END.

The heavier lines and dots indicate the ore (limonite).

d

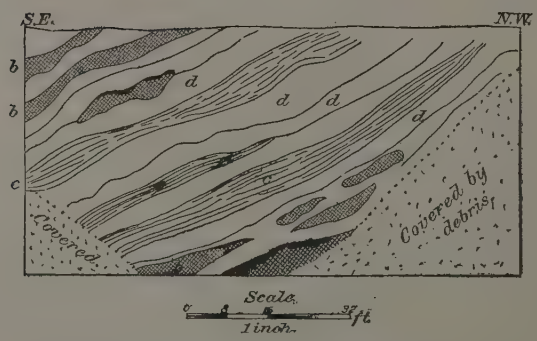


e

1066.

ENSOR MINE.

f



a.—Limonite. b.—Limonite-bearing beds.
c.—Beds of soft, light-red schist (ferruginous).
d.—Barren clay beds (decomposed schist).

FIG. 75.

mines preceding, but at the western end is an exposure of very soft decomposed schist, containing much mica and a little quartz. This schist is of various colors—white, brown, yellow, and red—and contains in the darker layers above, limonite, occurring in seams which follow the direction of the folia of the schist. Below and to the left of the part represented by the section (Fig. 75) the schist is chiefly brown, and is very much contorted. The ore of the schist is most abundant in this latter part. The strike of the schist is north 30° east.

Analysis. a

	1060.	Remarks.
Metallic iron	41.62	Sample taken from a pile of about 40 tons of washed ore at the mine.
Phosphorus	0.243	
Phosphorus in 100 parts iron	0.584	

1061. *Oregon.* Limonite (lump). Same mine as 1060.

The lump-ore was sampled separately from a pile of about 60 tons at the mine.

Analysis. b

	1061.
Metallic iron	51.90
Phosphorus	0.262
Phosphorus in 100 parts iron	0.505

1062. *Green Spring.* Limonite (washed). Open cut situated one-half mile northwest of Stevenson's station, on the Green Spring branch of the Northern Central railroad, Baltimore county.

Here an excavation running nearly north and south, 700 feet long, 175 feet wide, and 90 feet deep, has been made. Three thousand six hundred tons of ore were sent from this mine to the Ashland furnace during the census c year. The ore is limonite, occurring irregularly in clays, in a similar manner to the ore of 1059. It is all washed by a steam-washer at the mine.

Analysis.

	1062.	Remarks.
Metallic iron	45.91	Sample taken from about 150 tons of washed ore at Stevenson's station.
Phosphorus	0.482	
Phosphorus in 100 parts iron	1.050	

1063. *Avondale.* Limonite (lump). Mine situated three-quarters, of a mile north of Avondale, or Beacham d station, Western Maryland railroad, Carroll county.

This mine has not been in operation for over a year, has been partially filled in, and, when visited, nothing of the ore could be seen. The pile of 5,000 tons of ore at the station belongs to the Ashland Furnace Company, and most of it was mined before January, 1880. Six thousand six hundred and three tons of ore were received at Ashland furnace from this vicinity during the census year.

Analysis.

	1063.	Remarks.
Metalic iron	48.50	Sample taken from a pile of about 5,000 tons of lump-ore at Avondale or Beacham station.
Phosphorus	0.987	
Phosphorus in 100 parts iron	2.035	

e

1064. *Springfield.* Magnetite. Mine situated 2 miles north of Sykesville (Baltimore and Ohio railroad) on Mr. Brown's land, Carroll county. Leased by Reed, Stickney & Co., of Baltimore.

At this locality mining was carried on thirty years ago, and there are a number of old shafts on the same north and south line. One of the more northerly shafts has been reopened within six months, and another, one-half mile south of it, is being reopened. The latter is rather inaccessible, and no ore has been raised from it. Its depth is said to be 160 feet, and it is said that the deposit is 4 feet thick. The former is the one which was sampled. The shaft is about 100 feet deep, nearly vertical, but bending to the south (in the direction of the length of the deposit) f near the bottom. Some ore has been shipped to Pittsburgh from this mine.

The rock is chloritic and hornblendic schist. The deposit is about 2 feet thick at the bottom of the shaft, and stands very nearly vertical. The strike of the schist and the magnetic bed is about north and south.

Analysis.

	1064.	Remarks.
Metallic iron	64.44	Sample taken from 10 tons of ore at mouth of shaft. This came from near the bottom of the shaft, and represents the whole thickness of the deposit (2 feet) at that point, including some poor ore.
Phosphorus	0.243	
Phosphorus in 100 parts iron	0.377	

a 1065. *Springfield.* Magnetite. Same mine as 1064.

Sample taken across the 2-foot thickness of the deposit, at bottom of shaft, about 100 feet from surface.

Analysis.

	1065.
Metallic iron	64.85
Phosphorus	0.251
Phosphorus in 100 parts iron	0.387

b 1066. *Ensor.* Limonite (fine, unwashed). Open cut situated on Jos. Scholl's land, 1 mile northeast of Unionville, Frederick county.

An excavation 200 feet long, 60 feet wide, and 50 feet deep has been made, running north 30° east. The marketable product during census year was 1,744 tons. At the bottom of the excavation is a deposit of solid limonite at least 7 feet thick in the part of the excavation where it is now exposed. This is the sort of ore which has been shipped, and it is represented by Sample 1067. This bed is marked *a* on the section, Fig. 75. Above this bed, and to a great extent collected into layers, inclosed in clay-beds (which have apparently resulted from the decomposition of schist *in situ*), is a fine or "wash" limonite, of which about 2,000 tons are piled up at the mine c awaiting the completion of a washer in order to utilize it. This is the ore which Sample 1066 represents. The constituent fragments of this wash-ore resemble in quality the lump-ore of Sample 1067. In this section the beds from which 1066 was derived are marked *b*. This ore goes to the Wrightsville Iron Company's furnace at Wrightsville, Pennsylvania.

Analysis.

	1066.	Remarks.
Metallic iron	41.41	Sample taken from 2,000 tons of fine, unwashed ore at the mine.
Phosphorus	0.665	
Phosphorus in 100 parts iron	1.606	

d 1067. *Ensor.* Limonite (lump). Same mine as 1066.

Sample represents the lump-ore of a pile of about 150 tons which came from the lowest part of the excavation.

Analysis.

	1067.
Metallic iron	49.52
Phosphorus	0.817
Phosphorus in 100 parts iron	1.650

e 1068. *Catoctin* or *Kunkel.* Limonite (fine, unwashed). Open cut one mile north of Catoctin furnace, J. B. Kunkel proprietor of mine and furnace.

There are four or five excavations or banks on the property, and this is the more northerly of the two at which there are steam-washers. The others were not being worked at time of visit. An excavation, about 300 feet long, 100 feet wide, and 70 feet deep has been made. The ore is limonite in fragments dispersed through a sandy clay which lies in horizontal beds, the ore fragments being also to some extent collected into beds. These beds, however, are not well defined, and are not regular in their occurrence throughout the mine, *i. e.*, vertical sections in various parts would differ considerably with regard to the distribution of the ore-beds through the clay. The ore-bearing clay is 20 to 50 feet thick. It rests upon limestone, and is overlaid by a bluish-gray, stiff clay, 20 to 30 feet thick, and unproductive. The proportion of the ore-bearing clay which is rich enough to go into the washer is very f variable, sometimes reaching as high as one-half the whole thickness. The amount of loss in washing is also very variable, the minimum being estimated at one-tenth, while the ordinary loss is one-half. A wire screen on the washer removes the finest particles (see Sample 1069 for the washed and screened ore). The ore after being washed and screened is run on a tramway to Catoctin furnace, where it is used for making charcoal iron.

Analysis.

	1068.	Remarks.
Metallic iron	40.05	Sample taken from about 25 tons of "ore thrown down" in the 150 feet long drift, and in two 10 feet long drifts near it.
Phosphorus	0.220	
Phosphorus in 100 parts iron	0.549	

1069. *Catoctin* or *Kunkel*. Limonite (washed and screened). Same mine as 1068. a
Sample represents several tons of washed and screened ore at the mine.

Analysis.

	1069.
Metallic iron	41.55
Phosphorus	0.188
Phosphorus in 100 parts iron	0.452

1070. *Grim's*. Limonite (lump). Open cut 1 mile south-southeast of New Midway station, on Frederick division b
of Pennsylvania railroad, on J. Grim's land, Frederick county.

A cut running northeast and southwest has been made along the southeast side of a belt just west of Jos. Grim's farm-house. The mine is leased by, and has been operated by, C. Duncan, Chambersburg, Pennsylvania. Some of the ore has been shipped to a furnace at Columbia, Pennsylvania. The excavation is 140 feet long, and about 15 feet average width; depth, 8 to 12 feet.

The greater part of the material exposed, and the source of most of the ore which has hitherto been obtained, is an imperfectly stratified mass of clay, sand, and fragments of limonite, usually a few inches in diameter, though they occur of all sizes downward, and a few are found as large as 2 feet in largest dimension.

Below the mass of ore-bearing clay and sand, along the bottom of the excavation, the edges of the upturned c
beds of a schistose rock, rather soft, and of a light color are exposed, and these beds inclose a conformable bed of limonite, the upper edge only of which can be seen. This bed is exposed here and there over a distance of about 75 feet, and its greatest thickness observed was 5 to 6 feet. A small portion of the lump-ore has been derived from this bed, the rest having come from the overlying material.

Analysis.

	1070.	Remarks.
Metallic iron	38.35	Sample taken from 50 tons of lump-ore at the mine. It represents the 5-foot bed, and also the lump ore left in the overlying *débris*.
Phosphorus	1.363	
Phosphorus in 100 parts iron	3.550	

d

1071. *Thomas*. Limonite (screened). Open cut situated one-half mile a little east of south of Frederick junction, Baltimore and Ohio railroad, on C. K. Thomas' land, Frederick county.

An excavation running about north and south, about 140 feet long, 30 feet wide, and 20 feet deep has been made. The ore, most of which is quite friable, occurs in nests and bunches of irregular shape, inclosed in a soft, light-colored material, in places stratified, and made up of finer calcareous, argillaceous, and siliceous fragments.

The greater part of the material excavated has to be washed in order to obtain any ore; it is screened before washing. No ore has been mined for nine to ten months, *i. e.*, since the summer of 1880:

Analysis. e

	1071.	Remarks.
Metallic iron	30.45	Sample taken from pile of 75 tons of screened but unwashed ore at the mine.
Phosphorus	0.752	
Phosphorus in 100 parts iron	2.470	

1075. *Bowery*. Limonite. Situated 1 mile west of Bowery furnace, on furnace property, 1½ miles north of Borden shaft, on the Cumberland and Piedmont railroad, Alleghany county.

The mine and furnace belong to the Cumberland Coal and Iron Company. The agent, James Kane, at Frostburg, stated that the mine was about worked out; that the deposit lay horizontally, and was 4 to 5 feet thick, resting f
on clay, and covered by sandy clay and soil. The furnace has been supplied with ore largely from Bedford county, Pennsylvania. On visiting the mine it was found that it was entered by three horizontal drifts, which were inaccessible on account of the caving in and giving way of the timbering. The rock in the neighborhood is a fine-grained, hard, rough-weathering sandstone.

Analysis.

	1075.	Remarks.
Metallic iron	44.68	Sample taken from the only ore to be found, *i. e.*, 2 or 3 tons scattered about at the entrance to the mine.
Phosphorus	0.188	
Phosphosus in 100 parts iron	0.421	

a 1076. *Frost.* Fossil. Mine situated just east of Ormon Frost's house, 3½ miles west of Cumberland, Alleghany county.

This mine has not been worked for twelve years, and the drift leading to it is fallen in and entirely inaccessible.

Analysis.

	1076.	Remarks.
Metallic iron	46.59	Sample from about a ton of ore scattered about at the entrance to the mine.
Phosphorus	0.217	
Phosphorus in 100 parts iron	0.466	

IRON ORE SAMPLE MAP OF VIRGINIA.

Geology from the Virginia State Survey 1881-2 by W.B. Rogers

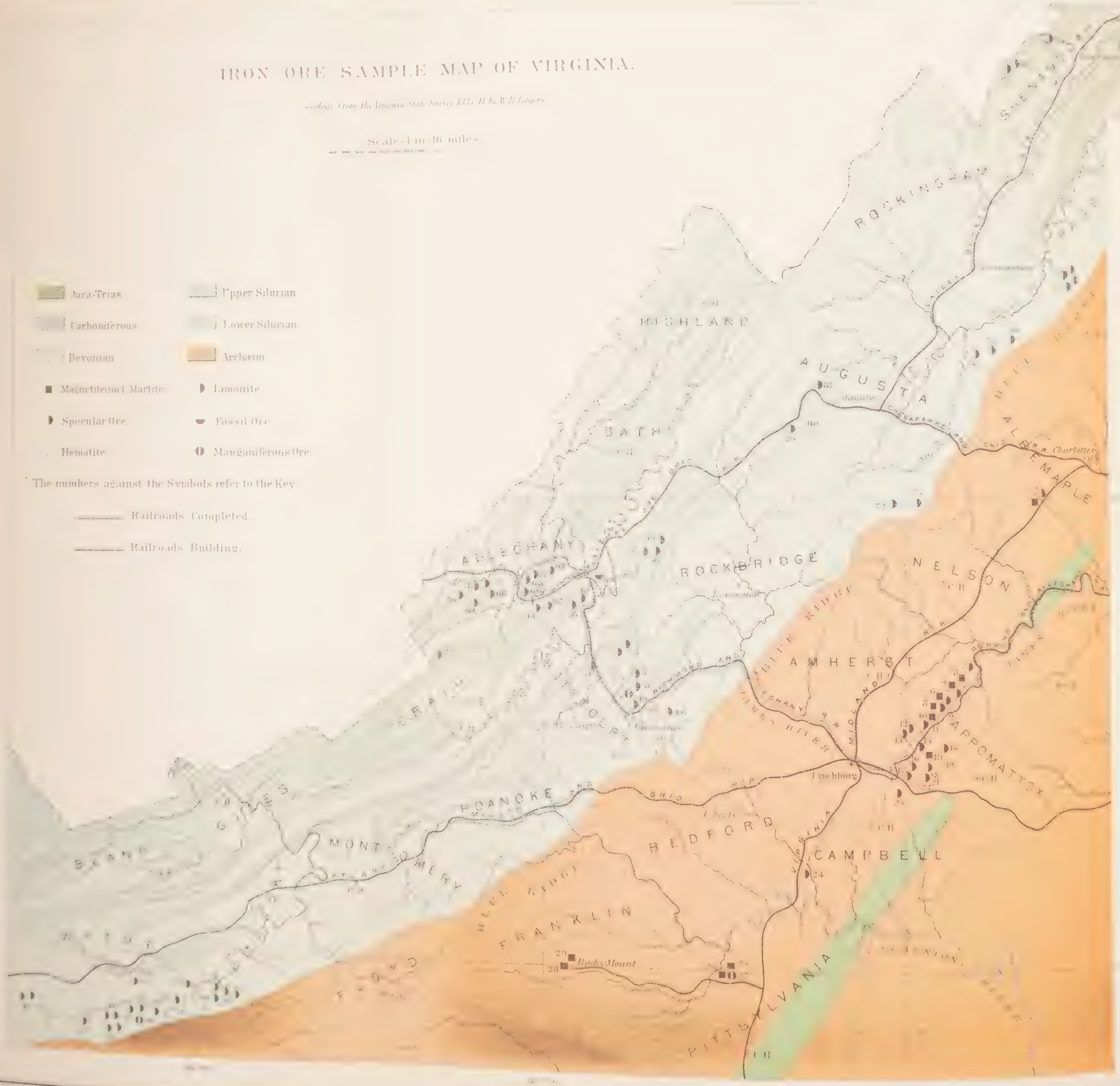
Scale-1 in-16 miles.

Jura-Trias
Carboniferous
Devonian
Magnetite and Martite
Specular Ore.
Hematite
Upper Silurian
Lower Silurian.
Archæan
Limonite
Fossil Ore
Manganiferous Ore.

The numbers against the Symbols refer to the Key.

Railroads Completed.

Railroads Building.



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a

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN VIRGINIA.

By Edward R. Benton.

That part of Virginia which contains the iron mines which were sampled, may, for convenience of reference, be divided as follows: b

A.—East of the Blue Ridge.

B.—Southwestern Virginia.

C.—James River basin, west of the Blue Ridge.

D.—Shenandoah valley.

The location and geological position of each mine or group of mines sampled is shown on Plate XXX. Fig. 76 indicates, with reference to its surroundings, the area represented on Plate XXX. As the sample numbers consist of three, and in some instances, four figures, it was found necessary, in order to avoid confusion, to use arbitrary numbers on the map. By reference to the *key to the numbers on the iron-ore sample map of Virginia* and the *index to the sample numbers* given below, the position on the map of a mine referred to in the text may readily be found. c

Key to the numbers on the iron-ore sample map of Virginia.

Map No.	Sample No.	Name of mine or group of mines.	Page No.
1	617	North Garden	263
2	610	Greenway	264
3	1014	Slippery Gut deposit	264
4	1015, 1016	East of Furnace vein	264
5	1017	Brown Hematite mine	265
6	608	Adams, Scott & Co: No. 13	266
7	609, 697	Adams, Scott & Co: No. 10½	265
	698	Adams, Scott & Co: No. 11	265
8	606	Dover Company, No. 11	266
9	605	Dover Company, No. 11	266
10	607	Dover Company, No. 6	267
11	604, 1018	Naylor & Co., No. 6½	267
12	601, 603	Maud vein, Stapleton	268
13	602, 603, 1012, 1013	Maud vein, Stapleton	268
14	699	Stonewall	269
15	1021	Chestnut Mountain	269
16	1019	Red Belt	269
17	1020	Railroad	269
18	623	Cross-cuts on Archer's Creek property	269
19	622	Cross-cuts on Archer's Creek property	269
20	621	Cross-cuts on Archer's Creek property	269
21	620	Cross-cuts on Archer's Creek property	269
22	619	Cross-cuts on Archer's Creek property	269
23	618	Near Oxford furnace	270
24	611	Otter River	270
25	612	Pittsville	270
26	613	Pittsville	270
27	614	Pittsville	270
28	615	Rocky Mount (Franklin)	271
29	616	Rocky Mount (Franklin)	271
30	634	Speedwell	273
31	635, 636	Ravenscliffe	273
32	637, 638	Sayers and Oglesby	274
33	639	Sampson's, Cripple creek	274
34	640	Chadwell Farm	274
35	641	Chadwell Farm	274
36	642	Noble	274
37	630	Walton	274
38	625	Carter	275
39	627	Hurst	275
40	626, 628	Johnson	275
41	629	Rich Hill	276
42	632, 633	Panic or White Rock	276
43	631	Glade	277
44	624	Semi-magnetic	277
45	645	Wood's property	277
46	644	Arcadia property	277
47	643	Arcadia property	277
48	650	Arcadia property	277 d
49	646	Retreat	278
50	647	Carnes	279
51	648	Spengler	279
52	651	May's	279
53	700, 1001	Hickory Hollow (Salisbury furnace)	279
54	649	Salisbury furnace	279
55	652	Longdale (Lucy Selina)	279
56	653	Longdale (Lucy Selina)	279
57	654	Longdale (Lucy Selina)	279
58	657	Clifton Forge	280
59	655	Callie furnace (Old bank)	281
60	656	Callie furnace (New bank)	281
61	659	Lowmoor	281
62	658	Lowmoor	281 e
63	1009	A. Given's outcrop, Potts' Crossing	283
64	1010	Dolly Ann	284
65	1011	Wills'	284
66	1003	Smith McAlister	284
67	1002	Dickey	284
68	1007	Gay and Lewis	284
69	1008	Huddleson	285
70	1004	Trice	285
71	1005, 1006	Sadler's or Stack	285
72	663	Kennedy	286
73	664	Mount Torrey or Virginia	286
74	673	Miller	286 f
75	674	Raines and Weaver	286
76	675	Raines	286
77	665, 666, 667, 668	Fox Mountain	287
78	670	Three-Top Mountain	287
79	661	Grace (formerly Ferrol)	288
80	662	Grace (formerly Ferrol)	288
81	660	Buffalo Gap	288
82	671	Old bank (Liberty furnace)	288
83	672	Hollow bank (Liberty furnace)	288
84	669	West bank (Van Buren furnace)	288

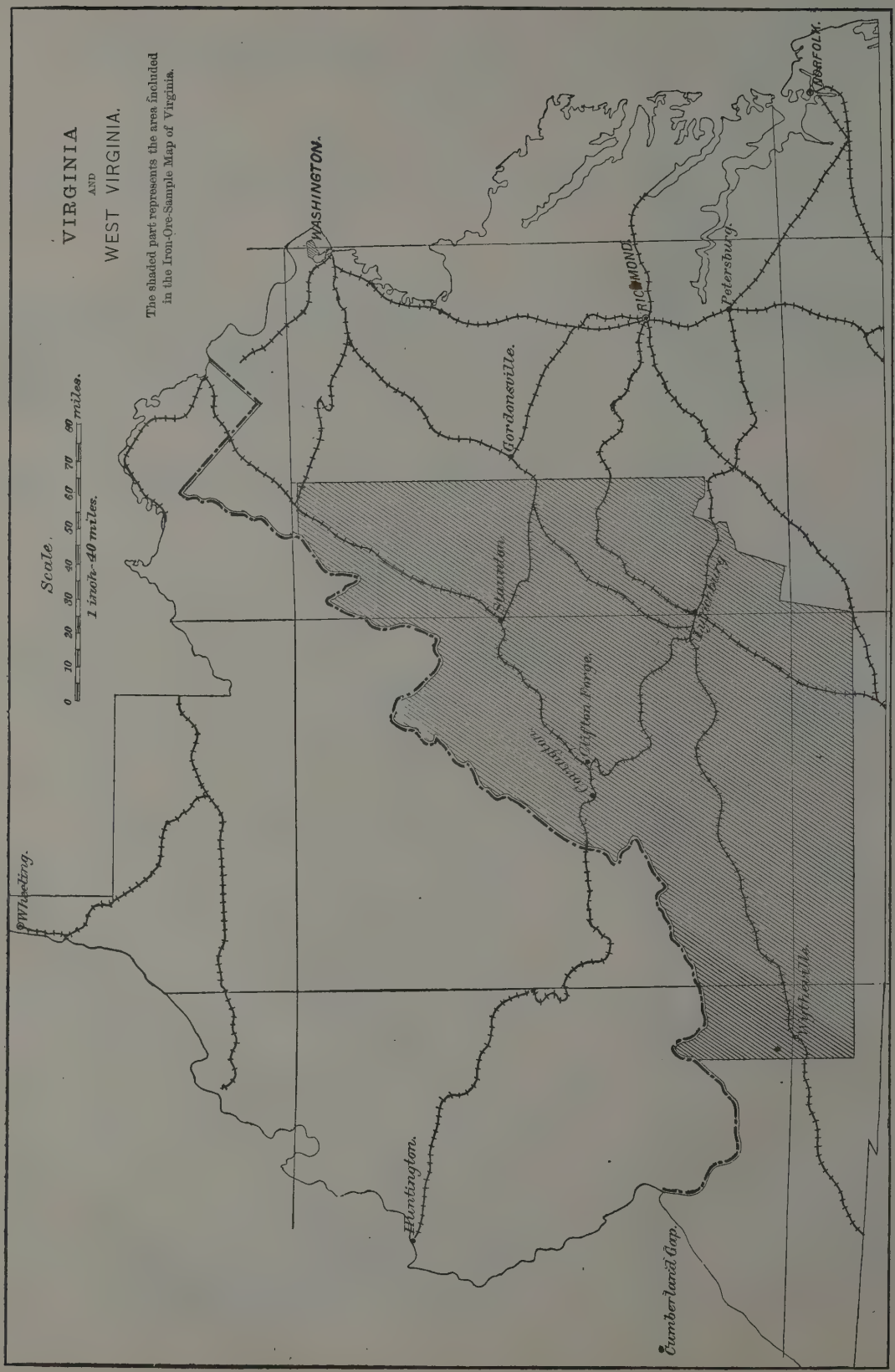
VIRGINIA
AND
WEST VIRGINIA.
The shaded part represents the area included in the Iron-Ore-Sample Map of Virginia.
Scale.
0 10 20 30 40 50 60 70 80 miles.
1 inch=40 miles.
WASHINGTON.
RICHMOND.
Petersburg.
NORFOLK.
Gordonsville.
Staunton.
Lynchburg.
Clifton Forge.
Covington.
Jeffersonville.
Wheeling.
Huntington.
Cumberland Gap.

FIG. 76.

Index to the sample numbers. a

[For finding on the map the location of the samples, and for finding description of same in the report.]

Sample No.	Page No.	County.	Map No.	Sample No.	Page No.	County.	Map No.	Sample No.	Page No.	County.	Map No.
601	268	Amherst	12	635	273	Wythe	31	669	288	Shenandoah	84
602	268	....do	13	636	273	....do	31	670	287	....do	78
603	268	....do	12, 13	637	274	....do	32	671	288	....do	82
604	267	....do	11	638	274	....do	32	672	288	... do	83
605	266	....do	9	639	274	....do	33	673	286	Rockingham	74
606	266	....do	8	640	274	....do	34	674	286	...do	75
607	267	....do	10	641	274	....do	35	675	286	....do	76 b
608	266	....do	6	642	274	....do	36	697	265	Amherst	7
609	265	....do	7	643	277	Botetourt	47	698	265	....do	7
610	264	Nelson	2	644	277	....do	46	699	269	Appomattox	14
611	270	Campbell	24	645	277	....do	45	700	279	Botetourt	53
612	270	Pittsylvania	25	646	278	....do	49	1001	279	....do	53
613	270	....do	26	647	279	....do	50	1002	284	Alleghany	67
614	270	....do	27	648	279	....do	51	1003	284	....do	66
615	271	Franklin	28	649	279	....do	54	1004	285	....do	70
616	271	....do	29	650	278	....do	48	1005	285	....do	71
617	263	Albemarle	1	651	279	....do	52	1006	285	....do	71
618	270	Campbell	23	652	279	Alleghany	55	1007	284	... do	68 c
619	269	....do	22	653	279	....do	56	1008	285	....do	69
620	269	Appomattox	21	654	279	.. do	57	1009	283	....do	63
621	269	....do	20	655	281	Botetourt	59	1010	284	....do	64
622	269	....do	19	656	281	....do	60	1011	284	....do	65
623	269	....do	18	657	280	Alleghany	58	1012	268	Amherst	13
624	277	Wythe	44	658	281	....do	62	1013	268	....do	13
625	275	....do	38	659	281	....do	61	1014	264	Nelson	3
626	275	....do	40	660	288	Augusta	81	1015	264	Amherst	4
627	275	... do	39	661	288	....do	79	1016	264	... do	4
628	275	Pulaski	40	662	288	....do	80	1017	265	....do	5
629	276	...do	41	663	286	... do	72	1018	267	....do	11
630	274	Wythe	37	664	286	...do	73	1019	269	Appomattox	16
631	277	....do	43	665	287	Rockingham	77	1020	269	Campbell	17 d
632	276	Smyth	42	666	287	...do	77	1021	269	Appomattox	15
633	276	....do	42	667	287	....do	77				
634	273	Wythe	30	668	287	....do	77				

A.—East of the Blue Ridge.

The iron-ore deposits of this division are, as a rule, interstratified with metamorphic schists and quartzites, or sandstones, which have a nearly vertical dip and a nearly northeast and southwest trend, and which are commonly considered by geologists to be of Archæan age. e

The former mine was worked in May, 1880, by Mr. Appelby, and 30 to 40 tons of ore were raised from an open cut 15 feet deep, at the time it was sampled. The latter mine ("Betty Martin", on Mrs. Martin's land) has been abandoned for some time. Some ore is said to have been shipped from it. Open cut, 20 to 30 feet deep.

These two small mines are near each other and contain, apparently, precisely similar ore. They were sampled as one, from 30 to 40 tons of ore in piles at each place.

617. *North Garden.* Magnetite and limonite (intimate mixture). One-half mile north of railroad station, at North Garden, Albemarle county, on Mrs. Betts' land; also, one-quarter mile northwest of station, on Mrs. Martin's land.

617. Analysis: Iron, 46.69 per cent.; phosphorus, 0.055 per cent. titanic acid, present; manganese, present; phosphorus ratio, 0.118.

JAMES RIVER ORE-BELT. f

This is the principal iron-mining region east of the Blue Ridge. It is situated along that part of the James river which forms the boundary between the counties Nelson and Amherst on the northwest and Buckingham, Appomattox, and Campbell on the southeast. The southwestern extremity of the region is about 5 or 6 miles south-southeast of Lynchburg (down the James river), and the region where mining has gone on extends for about 30 miles to the northeast. Measuring across the belt, the greatest distance between any two mines is about 3 miles.

a 610. *Greenway.* Specular (micaceous, soft). Two and one-half miles nearly west of Greenway post-office, which is on James river, and about 2½ miles north of Allen's Creek post-office, which is also on James river. Colonel Thomas Dunlap (who lives at Stapleton) manages the mine for Naylor & Co., Philadelphia. J. Lee Warne has charge at the mine.

This mine is worked by two shafts; it is said to have been opened for 500 feet along the deposit (northeast and southwest), and to a depth of 205 feet. The chief miner, who had charge of the mine, stated that the machinery was unsafe, and that the lower part of the mine was flooded; also that the deposit was 12 feet thick at the bottom of the mine. A small steam-engine is used for hoisting. Hand-specimen 610*a* is from the southwestern shaft, and is rather better in appearance than the average of the ore from that shaft. Hand-specimen 610*b* is from the northeastern
b shaft, and in order to obtain a specimen that would hold together, it was taken a little better than the average. The hand-specimens represent very well the different structure of the ore in the two shafts.

c

d

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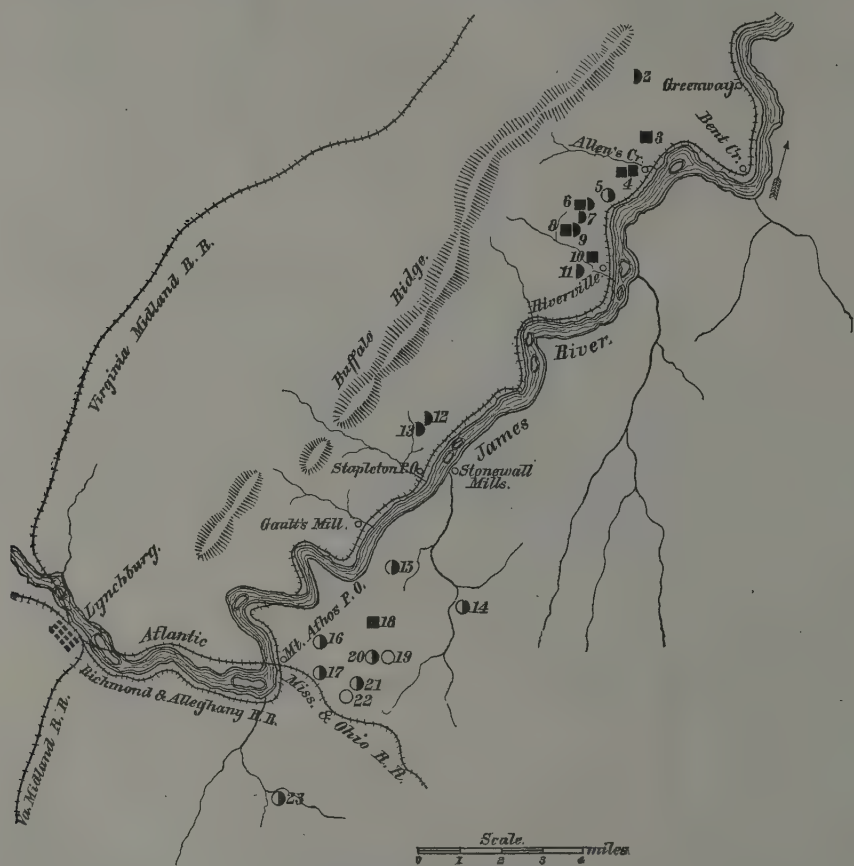


FIG. 77.—MAP OF THE JAMES RIVER IRON-ORE BELT. The numbers refer to the key to the iron-ore sample map of Virginia (p. 261).

610. Analysis: Iron, 53.02 per cent.; phosphorus, 0.049 per cent.; titanic acid, none; phosphorus ratio, 0.092. Sample taken from piles of ore ready for shipment at the two shafts; about equal amount at each. In shipping the two kinds go in together.

f 1014. *Slippery Gut Deposit.* Ferruginous schist. Three-fourths of a mile west of Dr. Megginson's house (which is 1 mile down James river from Allen's Creek post-office), along top of a ridge on Dr. Mundy's land. Lease or mineral right held by Mumford, Grubb & Co., Lynchburg Iron, Steel and Mining Company.

No mining has been done. The schist affects the magnetic needle slightly, but it has not the appearance of being a workable ore.

1014. Analysis: Iron, 24.67 per cent.; phosphorus, 0.121 per cent.; titanic acid, none; phosphorus ratio, 0.490. Sample taken across the 60-foot thickness of the formation on the outcrop.

1016. *"First Vein" east of "Old Furnace Vein."* "Specular," with magnetite. Near Old Elk Creek furnace, Amherst county, about three-fourths of a mile north of Dr. Mundy's house, on his land. Leased by Mumford, Grubb & Co., Lynchburg Iron, Steel and Mining Company. Mr. Grant has charge of this mine.

The ore-bed dips 70° southeast, and runs northeast and southwest. (It lies a few rods east of the old "Furnace vein", mined many years ago to supply Elk Creek furnace, near by. The workings of this old "vein" are now

inaccessible.) The mine is entered by a shaft 60 feet deep. Drift to northeast 125 feet long from bottom of shaft. **a** Deposit said (by miners) to be ordinarily 3 feet thick, but at end of drift was only 1 foot 3 inches thick. It was, however, somewhat richer than the ordinary run of the deposit, even when compared with picked ore from the rest of the deposit. This thin but rich part of the seam is represented by hand-specimen 1016*a*, while the ore ordinarily mined is represented by 1016. Ore will be used in the furnace of the Lynchburg Iron, Steel and Mining Company, Lynchburg.

1016. Analysis: Iron, 38.43 per cent.; phosphorus, 0.118 per cent.; titanic acid, small amount; phosphorus ratio, 0.307. Sample represents the output of the mine, from pile of picked ore at the mouth of the shaft.

1015. *"Second Vein" east of "Old Furnace Vein."* "Blue ore." Magnetite and martite. Near Old Elk Creek furnace, Amherst county, about three-fourths of a mile north of Dr. Mundy's house, on his land. Leased by **b** Mumford, Grubb & Co., Lynchburg Iron, Steel and Mining Company. Mr. Grant has charge of this mine.

Ore-bed dips 60° to 70° southeast; runs northeast and southwest (it lies a few rods east of 1016); is entered by tunnel at foot of hill about on level with the drift in 1016. Foot-wall is "slate"; the hanging-wall is sandstone or quartzite. A drift has been run southwest about 50 feet along the deposit from the point where the tunnel strikes the deposit. At the head of the drift the bed is about 1 foot thick. (All ore.) The ore is finely granular, and consists of martite, with some magnetite dispersed through it. This ore will be used in the furnace of the Lynchburg Iron, Steel and Mining Company, Lynchburg.

1015. Analysis: Iron, 46.63 per cent.; phosphorus, 0.057 per cent.; titanic acid, none; phosphorus ratio, 0.122. Sample taken across the 1-foot thickness of the deposit, head of drift, 50 feet southwest of tunnel, 20 to 30 feet from surface. **c**

1017. *Brown Hematite Mine.* Limonite. One-half of a mile west of Dr. Mundy's house, on his farm, and about one-quarter of a mile from James river. Leased by Mumford, Grubb & Co., Lynchburg Iron, Steel and Mining Company. Mr. Grant has charge of the mine. This ore is used in the furnace of the Lynchburg Iron, Steel and Mining Company, Lynchburg.

This mine was started as an open cut, but is now worked by a shaft 40 feet deep. The deposit stands vertical, and the walls are soft decomposed slate or schist. The ore is fragmental, apparently from crushing. A drift about 100 feet long has been run from the bottom of the shaft toward the southwest, and a tunnel is being run in from the hillside to connect with it.

1017. Analysis: Iron, 44.54 per cent.; phosphorus, 0.850 per cent.; titanic acid, small amount; phosphorus ratio, 1.908. Sample taken close to shaft in stope, about 20 feet from top of shaft. Thickness at point where sample was taken, 8 feet. **d**

609 and 697. *Adams, Scott & Co. No.* 10½. Specular (soft). One and one-half miles north of Riverville post-office, which is on the James river. Leased by Adams, Scott & Co. Dr. Scott has charge at the mine. Ore used in the furnace at Lynchburg.

Shaft 105 feet deep. Deposit stands vertical. Walls, slate and sandstone. Strike of bed northeast and southwest. Drift to southwest about 150 feet long from bottom of shaft. At this point (*i. e.*, head of drift) the thickness of the head is 14 to 15 feet. Of this thickness about half is solid, and the other half is fine, loose ore. A large amount of ore has been mined from the stopes above this drift. **e**

609. Analysis: Iron, 40.51 per cent.; phosphorus, 0.095 per cent.; titanic acid, none; phosphorus ratio, 0.235. Sample taken across the 14- to 15-foot thickness of the deposit at the head of the drift, and across the 16½-foot thickness of the deposit at the bottom of the shaft, sampling the two kinds of ore together at both points.

697. Analysis: Iron, 41.55 per cent.; phosphorus, 0.044 per cent.; titanic acid, small amount; manganese, trace; phosphorus ratio, 0.106. Sample taken at bottom of shaft across a layer of fine, loose ore 6½ feet thick, on the southeast wall of the deposit. Whole thickness at this point, 17½ feet.

698. *Adams, Scott & Co. No.* 11. "Specular" (soft). One and one-half miles north of Riverville post-office, which is on the James river, a few rods west of No. 10½. Leased by Adams, Scott & Co. Dr. Scott has charge at the mine. Ore used in the furnace at Lynchburg. **f**

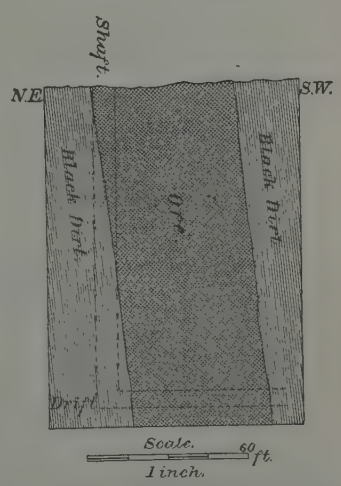


FIG. 78.—LONGITUDINAL SECTION, ADAMS, SCOTT & COMPANY'S MINE ON NO. 11. JAMES RIVER, VIRGINIA.

This ore-seam runs parallel with No. 10½. It stands vertically, and is entered by shaft 120 feet deep. From the bottom of the shaft a drift runs to the southwest 65 feet. Near the head of the drift the ore-deposit is 4 feet thick. At the bottom of the shaft the ore is wanting, its place being supplied by "black dirt". It was found in sinking the shaft, that one edge of the body of ore ran obliquely across it with an almost vertical pitch to the southwest. At a distance of 64 feet from the shaft, in the drift, it is seen that the ore is replaced by "black dirt", and the boundary between ore and black dirt turns obliquely upward, parallel with the boundary noticed in the shaft; between the two boundaries is the ore-body, and on each side is "black dirt". It was found by measurements taken in the mine and at the surface that this "shoot" of ore had a pitch to the southwest of 85° (see Fig. 78).

698. Analysis: Iron, 39.75 per cent.; phosphorus, 0.126 per cent.; titanic acid, small amount; phosphorus ratio, 0.317. Sample taken from pile of ore ready for shipment at mouth of shaft, which came from near the head of the drift. Thickness, 4 feet.

a 608. *Adams, Scott & Co. No.* 13. Specular (fine, loose), magnetite intermingled. One and one-half miles north of Riverville post-office, which is on the James river, and a few rods west of No. 11. Leased by Adams, Scott & Co. Dr. Scott has charge at the mine.

The greater part of the ore and rock in this mine is in a soft pulverulent state, so that the extent and shape of the deposit could not be determined. There was apparently no distinct foot-wall or hanging-wall. The hand-specimen 608 represents a small deposit of solid ore which was found some time since in the mine. Shaft 100 feet deep. Drifts both ways have been begun. The ore is a sand made up of grains of hematite and magnetic ore.

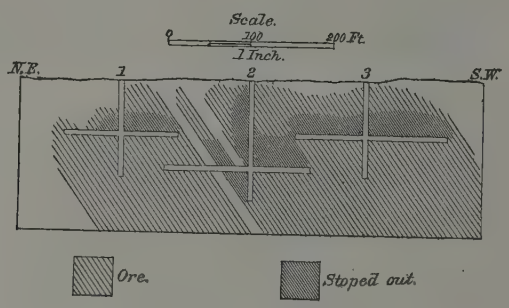
608. Analysis: Iron, 44.96 per cent.; phosphorus, 0.051 per cent.; titanic acid, small amount; phosphorus ratio, 0.113. Sample taken from ore-pile at top of shaft. The ore came from the bottom of the shaft, at depth of 100 feet.

b 605 and 606. *Dover Company No.* 11. Specular and hard hematite (martite). One and one-half miles northwest of Riverville post-office. Leased by Dover Mining Company, of New York. A tramway was built by the company from the mine to the canal wharf at Riverville. Ore used in the furnace at Lynchburg.

This mine was worked by three shafts (numbered 1, 2, and 3 on the sections, Fig. 79). They are sunk on the "vein" at an inclination of about 70° southeast. The hanging-wall is a quartzite or sandstone, usually much decomposed in the neighborhood of the ore. The foot-wall is a talcose or hydromica-slate or schist—very soft near the ore.

LONGITUDINAL SECTION OF THE WORKINGS.

c



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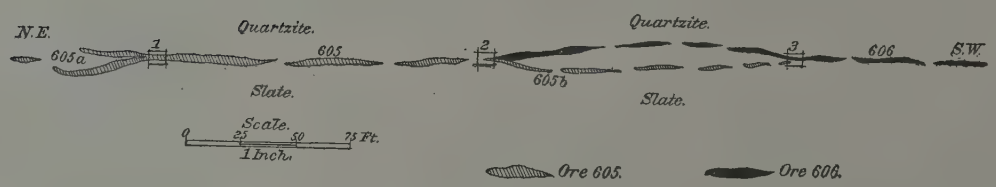
HORIZONTAL SECTION OF THE DEPOSIT ON THE LEVEL OF THE DRIFTS.



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CROSS-SECTION BETWEEN SHAFTS 2 & 3.

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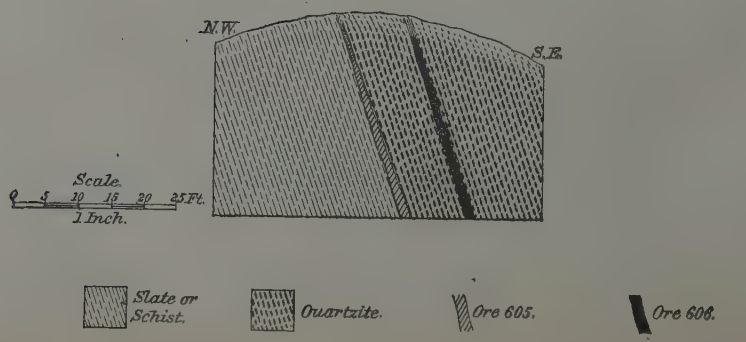

FIG. 79—SECTIONS OF THE DOVER COMPANY'S MINE ON NO. 11. JAMES RIVER, VIRGINIA.

Shaft No. 1 is down 88 feet; at depth of 60 feet is a drift running both ways—to northeast 60 feet and to a southwest 50 feet. Here the deposit varies in thickness from 3 feet down to 0. At the bottom of the shaft the ore is exposed with a thickness of 3 to 4 feet.

At Shaft No. 2 the main deposit is met by another, which is a different kind of ore, called, locally, "steel-ore" (hand-specimen 606). For most of its length it runs parallel with the other, and at a distance of about 10 feet in the hanging-wall (*i. e.*, on the southeast side of the main deposit). Shaft No. 2 is 115 feet in depth; at depth of 82 feet is a drift running both ways—100 feet to the northeast and 45 to 50 feet to the southwest. Both "veins" are exposed in this part of the mine, both in the southwest drift and in the bottom of the shaft. Thickness of each deposit about 1½ feet.

Shaft No. 3 is 105 feet deep; at depth of 60 feet is a drift running both ways—to northeast 80 feet and to southwest nearly 100 feet. The main deposit seems not to continue to the southwest beyond this shaft, but the b "steel vein" continues the length of the drift. Neither of the deposits in this mine is quite continuous, but they seem to run out and then come in again.

In the main deposit the ore in the northeastern part (represented by hand-specimen 605*a*) is almost entirely micaceous specular, whereas in the southwestern part the ore, though largely specular, contains many fine crystals of magnetic iron dispersed through it. This sort is represented by hand-specimen 605*b*. The two varieties are mined and shipped irrespective of the difference in composition, while the ore of the "steel vein" is kept separate. Some barite occurs in connection with this latter sort.

605. Analysis: Iron, 48.47 per cent.; phosphorus, 0.103 per cent.; titanic acid, small amount; phosphorus ratio, 0.212 per cent. Sample taken at heads of drifts in shafts No. 1 and No. 2. Thickness, 1½ to 3 feet. Sample represents the specular ore with some c little magnetite intermingled.

606. Analysis: Iron, 54.88 per cent.; phosphorus, 0.061 per cent.; titanic acid, small amount; phosphorus ratio, 0.111 per cent. Sample represents the hard hematite ore, and was taken at the heads of the two drifts in Shaft No. 3, on the "steel vein".

Following are the complete analyses of samples 605 and 606:

	605.	606.		605.	606.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sulphur	0.352	0.579	Hygroscopic water	0.07	0.07
Phosphorus	0.103	0.061	Water of composition	0.85	0.52
Iron, metallic	48.47	54.88	Total	100.069	99.961
Silica	21.58	14.00	Per cent. of insoluble silicious matter	28.53	20.71
Iron, protoxide	6.03	13.67			
Iron, peroxide	62.35	63.01	Silica	21.58	14.00
Alumina	4.94	2.93	Alumina (with trace of oxide of iron)	4.12	2.92
Lime	0.28	0.73	Lime	0.01	0.05
Magnesia	0.37	0.26	Magnesia	0.31	0.21
Iron, disulphide	0.320	0.300	Potassa	0.91	0.46
Barium oxide	1.18	2.11	Soda	0.11	0.06
Potassa	0.99	0.54	Phosphoric acid	0.028	0.002
Soda	0.14	0.10	Barium sulphate	1.32	3.04
Carbonic acid	0.21	0.54	Titanic acid	0.07	0.00
Sulphuric acid	0.45	1.04			
Phosphoric acid	0.239	0.141	Total	28.458	20.742
Titanic acid	0.07	Trace.			

d

e

607. *Dover Company, No.* 6. Hard hematite (martite). One-half mile northwest of Riverville, on Captain J. Dillard's land.

Short open cut from which 20 to 30 tons of ore have been taken. The ore sampled came from within 7 to 10 feet of the surface. The deposit stands vertical, and the walls are of soft slate; thickness, 3 to 4 feet.

607. Analysis: Iron, 36.10 per cent.; phosphorus, 0.131 per cent.; titanic acid, none; phosphorus ratio, 0.363 per cent. Sample taken f from pile of ore at the cut.

604 and 1018. *Naylor & Co., No.* 6½. Specular. Three-quarters mile west of Riverville post-office. Owned and managed by Naylor & Co., Philadelphia. Mr. Carlis has charge of the mine. Ore goes to northern markets.

The northeast shaft is about 41 feet deep on the slant of 60° toward the southeast. The shaft goes down upon the ore-bed. At the bottom is a drift toward the northeast 25 feet long at the head of which the deposit is 3 to 4 feet thick.

The southwest shaft, about 200 feet from the other, is 15 feet above it at the top, and is 45 feet deep. At the bottom of this shaft the deposit is 1 foot thick. The ore is soft specular, and contains occasional thin bands of hard, fine granular hematite. In the hand-specimen 604 the hard hematite predominates, but the great part of the ore in this mine is in appearance precisely similar to hand-specimen 610*a*.

a 604. Analysis: Iron, 48.92 per cent.; phosphorus, 0.033 per cent.; titanic acid, none; phosphorus ratio, 0.067 per cent. Sample taken from stope close to bottom of northeast shaft, thickness 3 feet; and from bottom of southwest shaft thickness 1 foot; depth, 40 feet. Not to be picked over before shipment.

The above sample and notes were taken in April, 1880. In December, 1880, the northeast shaft had been sunk to a depth of 115 feet, and a drift run at that level to the northeast 25 feet. Walls of this mine are soft slate. The ore in this part of the mine contains scarce any of the hard hematite, and is precisely similar in appearance to hand-specimen 610*a*.

1018. Analysis: Iron, 51.14 per cent.; phosphorus, 0.012 per cent.; titanic acid, none; phosphorus ratio, 0.023 per cent. Sample taken in drift a few feet northeast of northeast shaft, across the 1-foot thickness of ore, and at a depth of 115 feet. Not to be picked over before shipment.

b 601, 602, 603, 1012, 1013. *Maud vein, Stapleton.* Specular. One and one-quarter mile north of Stapleton, which is on the James river. Naylor & Co. Colonel Thomas Dunlap, manager at mine.

This deposit runs nearly north-northeast and south-southwest, stands nearly vertical, has for a foot-wall (on the west) a talcose or hydromica slate, and for a hanging-wall (on the east) a coarse "quartzite", which has an imperfectly stratified structure. On each side of the deposit is a layer of clayey substance between the ore and the inclosing rock. This substance is light to dark-yellowish brown. On the west wall it is only a few inches thick, while on the east wall it varies from 6 inches to 1½ feet thick.

The deposit is essentially a ferriferous slate (or schist) and "quartzite", approaching in character in some parts c of the mine pure specular ore. Thin layers of schist and "quartzite" are found interlaminated with the ore. The deposit consists, in an imperfect way, of two different layers placed vertically side by side, that on the west being darker colored, less slaty in structure, and apparently richer in iron; this kind of ore forms about one-half of the deposit, and is represented by hand-specimen 603. The other kind of ore, called locally "slate ore", forms the rest of the deposit, and is represented by hand-specimen 602. (See cross-section, fig. 80.)

This deposit has been opened about 800 to 900 feet of its length; greatest depth below surface, 80 feet. (See longitudinal section.)

LONGITUDINAL SECTION OF WORKINGS.

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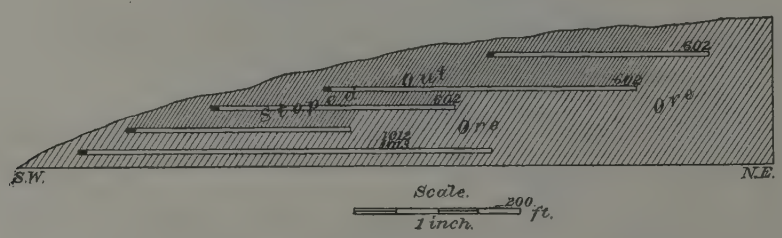
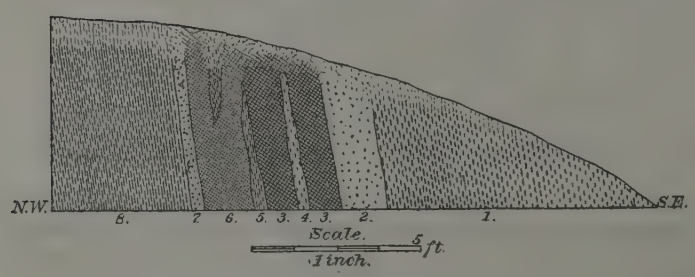


DIAGRAMMATIC CROSS-SECTION:

1 and 4—Quartzite. 5 and 8—Slate. 2 and 7—Clay.
3.—ORE (602.) *6.*—ORE (602.)

e



f FIG. 80.—SECTIONS OF THE MAUD VEIN, JAMES RIVER, VIRGINIA.

A narrow-gauge railroad is in process of construction from the mine to the canal-wharf at Stapleton. The intention is to run all the ore out of the mine through the "tunnel" which has been started below (about 25 feet below) the present four levels. The railroad now building is to connect with this tunnel.

602. Analysis: Iron, 49.89 per cent.; phosphorus, 0.139 per cent.; titanic acid, none; phosphorus ratio, 0.279. Sample taken across the 2 to 4 feet thickness of the deposit, in the stopes near heads of the upper three drifts. Average thickness, about 3 feet.

The above sample was taken in April, 1880, and was taken without regard to the two varieties of ore mentioned above. The occurrence of these two varieties was noticed especially in the upper two levels. The mine was visited again in December, 1880, for the purpose of sampling the two varieties separately. The particular spots where they were seen in April were not accessible, and all the good exposures across the deposit failed to present the

varieties before noted. These good exposures were 40 to 80 feet below the levels where the varieties were seen in April. Two slightly different varieties were, however, found in the "tunnel" below the four drifts. This "tunnel" is merely a drift, connecting with the tramway by a tunnel through about 80 feet of "quartzite" and "slate". a

1012. Analysis: Iron, 50.33 per cent.; phosphorus, 0.136 per cent.; titanic acid, none; phosphorus ratio, 0.270. Sample taken across a thickness of 6 inches of ore on the west wall of the deposit, in stope just above the lowest drift, *i. e.*, the one connected with the tramway, 500 feet from the mouth of the tunnel.

1013. Analysis: Iron, 48.16 per cent.; phosphorus, 0.120 per cent.; titanic acid, none; phosphorus ratio, 0.428. Sample taken across the thickness of 2 feet 6 inches of ore on the east wall of the deposit, at same point as sample 1012.

About 20 feet east of the northeast end of the workings on the main deposit a shaft had been sunk (April, 1880) 30 feet, upon a "shoot" of rather pure specular ore, having a slaty structure. From the bottom of the shaft the excavation goes down about 30 feet, toward the southwest on the shoot, at an angle of about 45°. Thickness of deposit, 4 to 5 feet. Hand-specimen 601 shows its character. b

601. Analysis: Iron, 51.21 per cent.; phosphorus, 0.096 per cent.; titanic acid, small amount; phosphorus ratio, 0.187. Sample taken near bottom of shaft on "shoot" of specular ore described above. Thickness, 4 to 5 feet.

603. Analysis: Iron, 56.50 per cent.; phosphorus, 0.129 per cent.; titanic acid, small amount; phosphorus ratio, 0.228. Sample taken to show output of mine from about 250 tons of ore on the canal wharf at Stapleton, ready for shipment and consisting chiefly of 602, but containing some of 601. This sample was taken in April, 1880.

699. *Stonewall.* Limonite. Near Stonewall creek, about 3 miles south of Stonewall (ferry), which is on the James river. Stonewall is about one half mile down the river (northeast) from Stapleton. The mine is managed by Colonel Thomas Dunlap. c

The mine consists of an open cut about 225 feet long, running up the hillside each way from a small valley which cuts through it. At no part is the excavation more than 20 feet below the surface. The ore dips 70° to 75° to the southeast; runs in a northeast and southwest direction, and has a thickness of about 3 feet. It is all lump-ore. The walls are decomposed schist, with thin seams of chert. Several hundred tons have been shipped from this mine. This ore has an imperfectly lamellar structure.

699. Analysis: Iron, 42.81 per cent.; phosphorus, 0.478 per cent.; titanic acid, small amount; manganese, small amount; phosphorus ratio, 1.116. Sample taken from three large piles of ore at the mine, containing all the ore that is taken out of the cut.

1021. *Chestnut Mountain.* Specular. Chestnut mountain, 3 miles northeast of Judge Williams' house, and on the land of the Birmingham Coal and Iron Company. Some little ore has been shipped from this mine.

Two shafts 125 feet apart, neither of them accessible. Shafts 100 feet deep, and connected at bottom by a drift, from which the ore represented by the sample was taken. d

1021. Analysis: Iron, 42.94; phosphorus, 0.012 per cent.; titanic acid, none; manganese, trace; phosphorus ratio, 0.028. Sample taken from a pile of 200 to 300 tons of ore ready for shipment at the mine. Mr. Logan, who has charge of the mining on the Birmingham property, stated that the ore came from the drift at depth of 100 feet, and that the deposit was 3 to 4 feet thick.

1019. *Red Belt.* Limonite. On the land of the Birmingham Coal and Iron Company, three-quarters of a mile southeast from Judge Williams' house, which is near the James river.

This mine was not in operation at the time it was visited, but mining had been done there a short time before, and it was expected to be resumed again in the spring. This ore, like that of 699, has an imperfectly lamellar structure, and is called "Red Belt", from containing occasional thin bands of red hematite. There is one shaft, which was not accessible. The ore-deposit stands vertical, and is said to be quite variable in thickness, but to attain in e places a thickness of 8 feet. Mr. Logan stated that there were two drifts, each 60 feet long, at the depth of 60 feet, one running northeast, the other southwest; and that there were also similar drifts at the depth of 40 feet.

1019. Analysis: Iron, 40.65 per cent.; phosphorus, 0.250 per cent.; titanic acid, small amount; phosphorus ratio, 0.615. Sample taken from pile containing 75 to 100 tons of ore at the mine (ready for shipment). Mr. Logan stated that it came from the 60-foot level.

1020. *Railroad.* Limonite. Land of Birmingham Coal and Iron Company, close to Atlantic, Mississippi and Ohio railroad, about 1 mile east of Mount Athos post-office.

Open cut, 25 feet long, and 10 to 15 feet deep. This ore is in a crushed state in the mine; it is screened, and about one-third is saved as good ore. The bed containing the ore stands vertical, and is about 20 feet thick. It consists, however, of alternating layers of sand and clay, so that about one-third only of the thickness is ore. The walls are decomposed schist and sandstone. f

1020. Analysis: Iron, 36.27 per cent.; phosphorus, 0.535 per cent.; titanic acid, small amount; manganese, small amount; phosphorus ratio, 1.476. Sample taken across the 20-foot thickness of the deposit, on face of ore in open cut, avoiding the intermingled clay and sand. It represents a thickness of 6 to 8 feet of good ore.

623. *Cross-cut, Archer's Creek property.* Hematite (martite). On Mr. Stone's land.

623. Analysis: Iron, 41.69 per cent.; phosphorus, 0.527 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 1.264, Sample across the 30-foot thickness of the deposit in cross-cut.

622. *Cross-cut, Archer's Creek property.* Hematite. Three-quarters mile northeast of Mr. Pettigrew's house, on his land.

A soft schistose ore.

a 622. Analysis: Iron, 32.31 per cent.; phosphorus, 0.357 per cent.; titanic acid, none; phosphorus ratio, 1.102. Sample taken in cross-cut, across the 3-foot thickness of the deposit.

621. *Cross cut, Archer's Creek property.* Limonite. Three-quarters mile northeast of Mr. Pettigrew's house, on Mr. Neighbor's land, 100 yards west of 622.

An imperfectly lamellar ore, resembling 699 and 1019.

621. Analysis: Iron, 44.40 per cent.; phosphorus, 0.630 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 1.419. Sample taken from ore-pile at cross-cut. The cut had been partially filled in again, so that the thickness could not be ascertained.

620. *Cross-cut, Archer's Creek property.* Limonite. Three-quarters mile northeast of Wright's mill, on Mr. Williams'
b land.

A compact, hard ore.

620. Analysis: Iron, 53.79 per cent.; phosphorus, 0.253 per cent.; titanic acid, none; phosphorus ratio, 0.470. Sample taken in cross-cut, across the 4-foot thickness of the deposit.

619. *Cross-cut, Archer's Creek property.* Hematite. One-half mile northeast of Wright's mill, on Mr. Williams' land.

A soft schistose ore.

619. Analysis: Iron, 34.12 per cent.; phosphorus, 0.120 per cent.; titanic acid, none; phosphorus ratio, 0.244. Sample taken in cross-cut, across the 2- to 3-foot thickness of the deposit.

618. *Near Oxford furnace.* Limonite (roasted). One-quarter to one-half mile southwest of the old Oxford furnace,
c which is about 3 miles south of Mount Athos post-office.

The furnace was abandoned some years since and is now dilapidated. Various cuts in the neighborhood, from which the furnace had been supplied, were visited, but no ore fit for a sample was found at the cuts, as the few fragments found were quite soft and greatly decomposed through long exposure. The ore-deposit extends northeast and southwest, and stands nearly vertical; said to be 1 to 3 feet thick.

618. Analysis: Iron, 50.73 per cent.; phosphorus, 0.577 per cent.; titanic acid, none; phosphorus ratio, 1.137. Sample taken from pile of ore at Oxford furnace. Mr. Banks, who formerly worked the furnace, stated that this ore had been roasted.

611. *Otter river.* Limonite. One mile and a half east of Otter river, a station on the Virginia Midland railroad, about 30 miles south of Lynchburg, on Mr. H. M. Oliver's land, one-quarter mile from his house, first ridge east.

d This ridge has many blocks and fragments of limonite scattered over it. Many test-pits have been dug, but usually without striking the ore. Shaft (inaccessible) sunk by L. D. Solomon, prospector and miner for the Pig River Mining Company. Mr. Oliver, the owner of the land, stated that the shaft was about 90 feet deep; that at the depth of 50 feet a drift had been run in toward the southeast without passing out of the ore; thickness not stated. No ore had been shipped from the mine.

611. Analysis: Iron, 34.19 per cent.; phosphorus, 0.613 per cent.; titanic acid, none; manganese, considerable amount; phosphorus ratio, 1.793. Sample from about 50 tons of ore at the shaft, said by Mr. Oliver to have come from the drift 50 feet below the surface. Thickness unknown.

612, 613, and 614. *Pittsville.* Magnetite and manganiferous magnetite. One-half mile from Pittsville junction of the Pittsylvania and Franklin Narrow Gauge railroad, 9 miles from Franklin junction of the Virginia
e Midland railroad.

The rock in the vicinity of the ore is decomposed and disintegrated to a considerable depth, so that in no part of the mine are solid walls to be observed. A bright-red to reddish-brown clayey or sandy substance is the result of the decomposition. Here and there parts of the rock have escaped entire disintegration, and it is seen that these parts were a fine-grained schist with magnetic grains disseminated through it. In many parts the structure of the rock is preserved, though the rock is ready to fall to pieces on being disturbed. In most of the places where this occurs it is seen that the dip of the ore-seam is coincident with that of the foliation of the rock.

In five shafts in the northern part of the mine (marked 612 on the plan) the dip of the ore-seam is toward the west and northwest; in three more widely-separated shafts south of these the deposit stands nearly vertical, while in the shaft still farther south (marked 613 and 614 on the plan) the dip is to the east and southeast. The dip varies in this mine from vertical to almost horizontal. The ore-deposit has been explored in this mine to a depth of
f 150 feet, and for about 2,500 feet of its length. On the sketch only those shafts are indicated from which ore is being or has been taken, though between 40 and 50 shafts and test-pits have been sunk, in most of which some ore has been found. The ore in the more northerly part of the mine is a hard, steel-gray, coarsely granular magnetite.

612. Analysis: Iron, 60.87 per cent.; phosphorus, 0.072 per cent.; titanic acid, none; manganese, trace; phosphorus ratio, 0.118. Sample taken from ore on cars (3) ready for shipment. This ore came from the five shafts in the northern part, marked 612 on the plan. Thickness, 1 to 3 feet; depth, 40 to 60 feet.

In the central and also in the more southerly part of the mine the ore contains more impurities, is more decomposed, and in general softer.

613. Analysis: Iron, 59.83 per cent.; phosphorus, 0.086 per cent.; titanic acid, trace; some manganese; phosphorus ratio, 0.144. Sample taken across the thickness of the deposit in short drifts at the bottom of the five shafts marked 613 on the plan. Ordinary thickness, 3 feet; varies from 2 to 5 feet; depth, 100 to 125 feet.

In two shafts in the central part of the mine (two of those from which 613 was taken), marked 614 on the plan, a a band of black, massive ore occurs alongside of the other ore. It is about 1 foot thick, and contains a large percentage of manganese. On each side of this band, and in places continuous with it, is a black pulverulent substance, said to consist largely of manganese.

614. Analysis: Iron, 26.13 per cent.; phosphorus, 0.117 per cent.; titanic acid, none; manganese, considerable amount; phosphorus ratio, 0.448. Sample taken in two shafts in central part of mine, marked 614 on plan. Thickness, 1 foot.

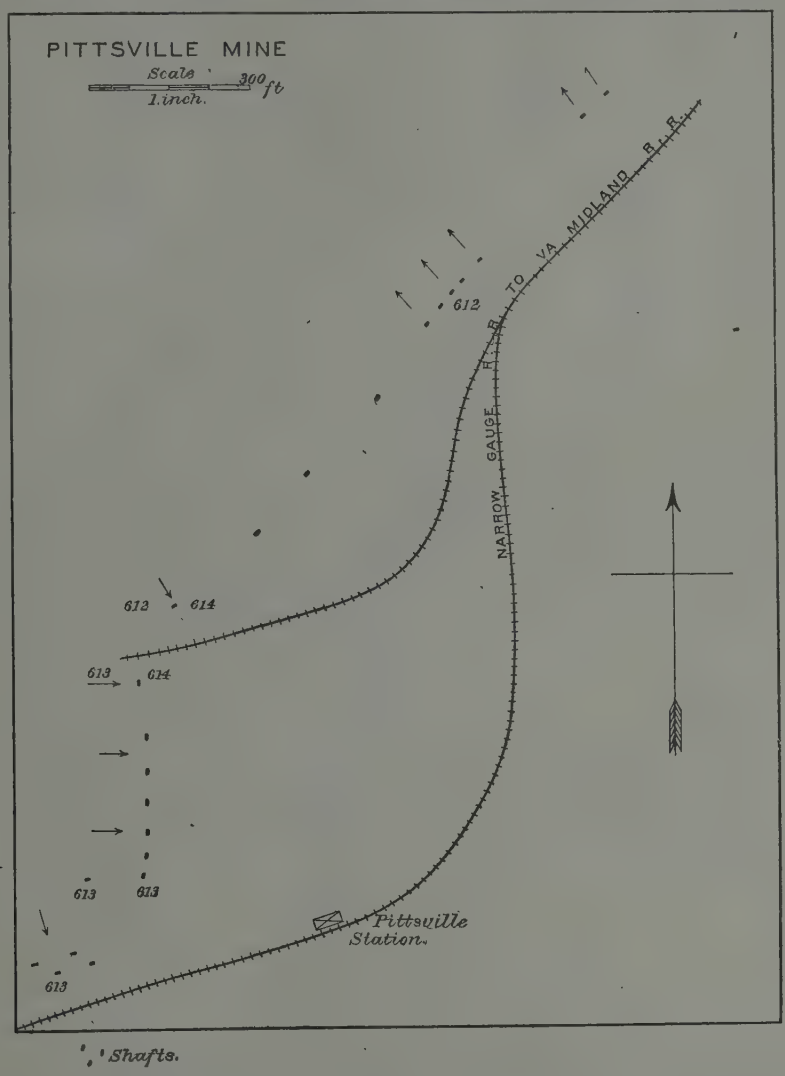
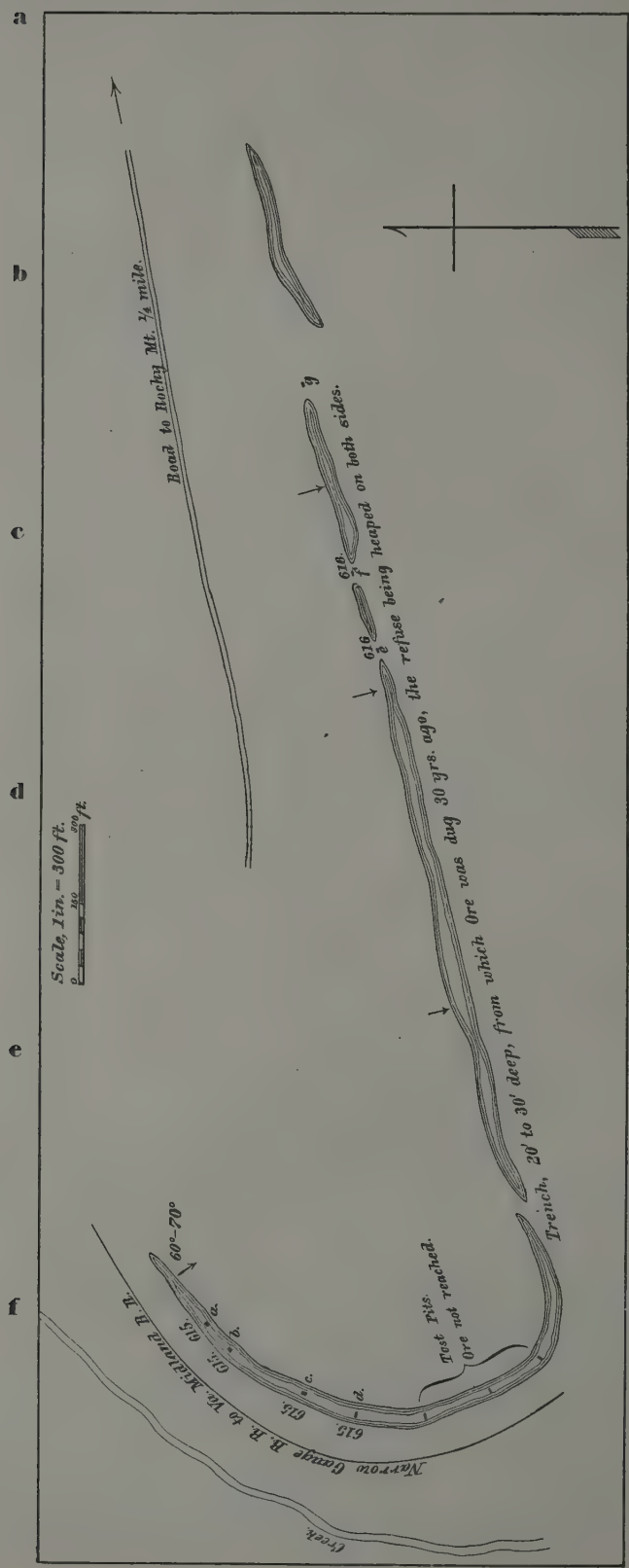


Fig. 81.

This mine has been worked about two years, and, according to the superintendent, 50,000 to 60,000 tons of ore f shipped to Pennsylvania Steel Company's furnace at Steelton, Pennsylvania. The land is leased, and the mine worked by the Pig River Mining Company, at the head of which is Major George Mason. Mr. Blackwell, ore agent of the Pennsylvania Steel Company, has had charge of the mine.

615 and 616. *Rocky Mount (Franklin).* Magnetite. One-half mile west of Rocky mountain (Franklin Court-House). Leased and worked by Pig River Mining Company. Ore goes to Pennsylvania Steel Company, Steelton, Pennsylvania.

The deposit is composed of two parts, which are supposed by those working the mine to be continuous. The western is the part now being worked (see Fig. 82). It runs nearly northeast and southwest, dipping 60° to 70° southeast. The rock in the immediate vicinity of the ore is very much decomposed, iron-stained, and broken up by fissures. As yet no solid walls are found adjoining the ore. The present company began work about three years



a Working shaft, 20 feet deep; ore 10 to 12 feet thick.
b Working shaft, 20 feet deep; ore 8 to 10 feet thick.
c Working shaft, 12 feet deep; ore 8 feet thick.
d Test-pits with ore in sight.
e Test-shaft with ore; sunk two years ago; depth 25 feet.
f Test-shaft with ore; sunk two years ago; depth 20 feet.
g Test-shaft with ore; sunk two years ago; depth 25 feet.

The numbers indicate the location of the samples; the arrows indicate the dip of the ore bed.

FIG. 52.—SKETCH OF THE OLD AND THE NEW WORKINGS ON THE IRON ORE DEPOSITS AT ROCKY POINT, VIRGINIA.

ago. They are working three shafts on the westerly deposit where the ore is 8 to 12 feet thick. Besides these a there is one test-pit with ore exposed, and three others in which ore had not been found at the time the mine was visited. The ore in the part worked is a very hard fine granular magnetite, quite uniform in appearance, with little rock intermingled.

615. Analysis: Iron, 53.59 per cent.; phosphorus, 0.018 per cent.; titanic acid, none; phosphorus ratio, 0.034. Sample taken across the 9-foot (average) thickness of the deposit in three shafts on the western part of the deposit; depth, 20 feet.

Following is the complete analysis of sample 615:

	615.		615.
	Per cent.		*Per cent.*
Sulphur	0.364	Carbon in carbonaceous matter	0.01
Phosphorus	0.018	Hygroscopic water	0.13
Iron, metallic	53.59	Water of composition	0.87
		Total	100.433
Silica	14.67		
Iron, protoxide	26.79	Per cent. of insoluble silicious matter	26.53
Iron, peroxide	46.33		
Alumina	2.77	Silica	14.67
Manganese, protoxide	0.12	Alumina (with a trace of oxide of iron)	2.46
Lime	4.21	Lime	2.79
Magnesia	2.80	Magnesia	2.29
Iron, disulphide	0.681	Ferrous oxide	4.28
Carbonic acid	1.01		
Phosphoric acid	0.042	Total	26.49

b

c

The more easterly deposit runs nearly east and west, and dips, as nearly as could be ascertained, at an angle of 45° to 50° to the southward. A large amount of ore was taken from this deposit about thirty years ago by open-cut workings. There are two test-shafts 30 feet deep (inaccessible) on this deposit, and the ore from them is softer and less magnetic than that of the westerly deposit.

616. Analysis: Iron, 43.00 per cent.; phosphorus, 0.203 per cent.; titanic acid, none; phosphorus ratio, 0.472. Sample taken from piles of weathered ore at the two test-shafts on the eastern deposit. Thickness not known.

d

B.—Southwestern Virginia.

The principal mining region of this division lies along the southeastern portion of Wythe county, at the northwestern base of that portion of the continuation of the Blue Ridge which is known as Poplar Camp mountain toward the northeast, and as Coal ridge in its more southwesterly portion. The region extends along a part of New river, and its tributary, Cripple creek, in an east-northeast and west-southwest direction. This may be called the Cripple Creek and New River belt. In this division of the state there are several mines which lie beyond the limits of the Cripple Creek and New River belt. e

CRIPPLE CREEK AND NEW RIVER BELT.

WESTERN BASE OF THE BLUE RIDGE.

These iron-ore deposits occur in connection with calcareous shales, calcareous sandstones, and impure limestones, which Professor William B. Rogers regarded as of Canadian age (*See The Virginias*, November, 1880, p. 170, where quotation from *Roger's Report on Geology of Virginia*, 1838, p. 16, is cited). Section 25, by W. B. & H. D. Rogers, gives these rocks as belonging to No. II of Rogers (the Canadian of Dana), (*The Virginias*, June, 1880, opp. p. 93).

634. *Speedwell.* Limonite. One mile south of Speedwell furnace. Owned and managed by David James & Co.

Ore disseminated in lumps and small fragments through the soil. It is roasted and washed, and used in f Speedwell furnace for making "neutral iron".

634. Analysis: Iron, 46.26 per cent.; phosphorus, 0.160 per cent.; titanic acid, trace; some manganese; phosphorus ratio, 0.346. Sample taken from a pile of washed ore at Speedwell furnace.

635 and 636. *Ravenscliffe.* Limonite. One-quarter mile south of Sayers & Oglesby, or Wythe furnace. Bank managed by Crockett, Tate & Co.

Small open cut. Rock in the neighborhood, limestone. Ore occurs in a fragmental state in the soil, and in the soft, crushed beds of brown, yellow, and white calcareous shale. This ore is washed and used in Ravenscliffe furnace for making "neutral iron".

636. Analysis: Iron, 42 23 per cent.; phosphorus, 0.165 per cent.; titanic acid, small amount; phosphorus ratio, 0.390. Sample taken from unwashed ore at the Ravenscliffe ore-bank.

a 635. Analysis: Iron, 56.29 per cent.; phosphorus, 0.156 per cent.; titanic acid, none; phosphorus ratio, 0.277. Sample taken from pile of washed ore at the washer.

Following are the complete analyses of the above samples:

	635.	636.		635.	636.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sulphur	0.094	0.063	Carbon in carbonaceous matter	0.06	0.03
Phosphorus	0.156	0.165	Hygroscopic water	1.17	1.23
Iron, metallic	56.29	42.23	Water of composition	11.07	10.44
			Total	99.954	100.192
Silica	4.70	17.64			
b Iron, protoxide	0.44	0.36	Per cent. of insoluble silicious matter	5.28	23.92
Iron, peroxide	79.73	59.79			
Alumina	1.24	7.88	Silica	4.70	17.64
Manganese, protoxide	0.28	0.57	Alumina (with trace of oxide of iron)	0.52	5.20
Lime	0.10	0.13	Lime	0.06	0.11
Magnesia	0.53	0.82	Magnesia		0.33
Iron, disulphide	0.176	0.118	Potassa		0.54
Potassa		0.54	Soda		0.13
Soda		0.13	Phosphoric acid		0.008
Carbonic acid	0.10	0.14	Titanic acid		Trace.
Phosphoric acid	0.358	0.374			
Titanic acid		Trace.	Total	5.28	23.958

c

637 and 638. *Sayers & Oglesby.* Limonite. One-half mile south of Sayers & Oglesby, or Wythe furnace. Bank managed by Sayers & Oglesby.

This ore is mined by an open cut, and occurs as fragments disseminated through the soil, and through the crushed and softened strata of clay and shale, the principal rock in the neighborhood being limestone. This ore is washed at Sayers & Oglesby furnace, and used there for making "neutral iron".

Two slightly different varieties of ore occur. In external characters they differ only in color, the one being yellowish brown, the other reddish brown. These are separated in mining, and used in the proportion of half-and-half in the furnace.

d 637. Analysis: Iron, 54.21 per cent.; phosphorus, 0.179 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 0.330. Sample taken from piles of "yellow ore", washed at Sayers & Oglesby furnace.

638. Analysis: Iron, 53.14 per cent.; phosphorus, 0.117 per cent.; TiO_2, none; Mn, small amount; phosphorus ratio, 0.220. Sample taken from piles of "red ore", washed at Sayers & Oglesby furnace.

639. *Sampson's, Cripple Creek.* Limonite. One-half mile south of Mr. Sampson's house, on his land.

Mining was carried on near by many years ago, and the ore used in Pierce's forge, Cripple creek; those banks are caved in, and nothing is to be seen.

639. Analysis: Iron, 51.15 per cent.; phosphorus, 0.086 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 0.168. Sample taken from small piles of ore at two small test-pits on Mr. Sampson's land.

640 and 641. *Chadwell Farm.* Limonite, and manganiferous limonite. One mile southwest of Brown Hill furnace,
e on Chadwell farm.

Test-pit. Between Pierce's mill and Sampson's house (both on Cripple creek) a road turns south from the Cripple Creek road. About half a mile to the south along this road, is a road through bars (to right) into the woods. This leads to a small test-pit, with a little manganiferous limonite exposed. No ore has been mined.

640. Analysis: Iron, 34.84 per cent.; phosphorus, 0.068 per cent.; titanic acid, none; manganese, large amount; phosphorus ratio, 0.195. Sample taken from small pile of ore at test-pit.

On the same farm (Chadwell), and on the road mentioned as leading south from the Cripple Creek road, and about one-quarter mile from that road, is an abandoned tunnel, from which ore was formerly obtained. This ore was smelted in Brown Hill furnace.

641. Analysis: Iron, 54.63 per cent.; phosphorus, 0.150 per cent.; titanic acid, none; phosphorus ratio, 0.275. Sample taken from piles of
f ore at mouth of tunnel.

642. *Noble.* Limonite. Two miles south of Brown Hill furnace.

This bank was not visited. The ore is used to supply Brown Hill furnace, belonging to the Lobdell Car-Wheel Company.

642. Analysis: Iron, 54.56 per cent.; phosphorus, 0.053 per cent.; titanic acid, none; phosphorus ratio, 0.097. Sample taken from pile of washed ore at Brown Hill furnace.

630. *Walton.* Limonite. One-half mile northeast of Walton furnace. Managed by Lobdell Car-Wheel Company.

Here the ore occurs disseminated in lumps and particles through the surface soil. It is worked by simply shoveling up the soil and washing it. It is used in Walton furnace for making "neutral iron".

630. Analysis: Iron, 58.58 per cent.; phosphorus, 0.051 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 0.087. Sample taken from piles of washed ore at Walton furnace.

625. *Carter.* Limonite. One mile northeast of Graham's old furnace, on Reed creek. Managed by Graham & Robinson. a

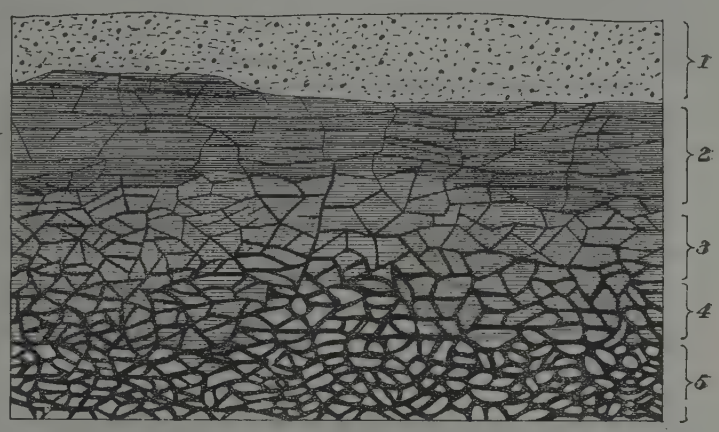
This deposit (or group of deposits) has supplied Cedar run, or Graham's old furnace, since 1839. The old workings, consisting of wholly irregular excavations, are fallen in so that nothing of them can be seen. The present workings consist of several test-pits and shafts, in only one of which, a shaft, has a workable amount of ore been found, and that is the present source of supply for the furnace.

This ore occurs in lumps of various sizes and in a finely-disseminated state, disseminated through a good deal of waste matter, which is chiefly yellow clay. The lumps are easily broken up after roasting, and the finely-divided ore is washed before being used in the furnace. The deposit forms irregular masses, inclosed in and mingled with the soil. At a short distance (50 to 100 feet) below the surface these masses narrow and run out. The rock in the vicinity is limestone. The product from this ore, "neutral iron." The iron has to be hauled 9 to 10 miles to Max Meadows station, on the Atlantic, Mississippi and Ohio railroad. b

625. Analysis: Iron, 55.04 per cent.; phosphorus, 0.113 per cent.; titanic acid, none; phosphorus ratio, 0.205. Sample taken from piles of washed ore at Cedar run, or Graham's old furnace.

627. *Hurst.* Limonite. West side of Little Reed Island creek, three-quarters mile from its junction with New river. Bank owned by David Forney.

This ore was dug from the steep bank of the creek. An exposure of it in this position appears to illustrate the manner in which this and other cavernous limonites from this region were formed. Under the few inches of soil is seen a horizontally-bedded limestone, the beds being one-half inch to 2 or 3 inches thick. A portion of this rock near the top has the bedding undisturbed, but toward the side and in going downward this regularity disappears, the laminæ being broken into small pieces and lying in every possible direction. In the regular part of the rock the crevices between the beds or laminæ and the fissures running across the same are filled to some extent with seams of limonite, their maximum thickness being one-quarter of an inch. Toward the more broken part of the rock the fissures are still more filled with limonite, and the inclosed bits of limestone are somewhat softened and discolored. Farther downward the thickness of these reticulating seams is greater, and the inclosed bits are composed of soft, fine sand or brown, yellow or drab ocher. In certain parts the inclosed portions have disappeared, and the result is a cavernous mass of limonite nearly pure. (See Fig. 83.) c d



1. Soil.
2. Limestone, with crevices filled with limonite.
3. Limestone, softened and decomposed, and containing in the crevices more ore than the above.
4. Meshwork of limonite, inclosing ocher and fine sand.
5. Ore, with cavities (cavernous or honey-comb ore). e

Below the soil the irregular lines represent limonite; the horizontal lines, limestone.

Fig—.83. HURST BANK, Wythe county, Virginia. Vertical section, to show the relation of the ore to the limestone. Scale, $\frac{1}{10}$ nature.

About 6 feet of thickness are exposed, the lower three-fourths being limonite ore. This deposit is exposed along the bank in a horizontal direction about 75 feet, but the openings made are not sufficient to show its extent. This ore has been used in Forney's forge for making bar-iron; makes "neutral iron".

627. Analysis: Iron, 56.43 per cent.; phosphorus, 0.023 per cent.; titanic acid, none; phosphorus ratio, 0.041. Sample taken across the 4-foot thickness of ore from top to bottom.

626 and 628. *Johnson.* Limonite. West side of Little Reed Island creek, one-half mile in a southerly direction from the junction with New river. f

This bank has been worked for some years to supply Forney's forge and Graham's new furnace. Irregular open cuts and excavations have been made. The ore is very cavernous limonite, requiring washing, on account of the intermingled ocher, clay, and sand, but not requiring roasting, as it is easily broken up. In places this ore forms a skeleton work running through the impure decomposed limestone; in general, however, all traces of the limestone, as such, have disappeared, and only the cavernous ore with the inclosed ocher remains. The case is similar to that described in connection with 627. Makes "neutral iron".

626. Analysis: Iron, 56.29 per cent.; phosphorus, 0.083 per cent.; titanic acid, none; phosphorus ratio, 0.148. Sample taken from piles of ore ready for shipment at the open cut in that part of the mine which has been worked for some years.

a Following is the complete analysis of sample 626:

	626.		626.
	Per cent.		*Per cent.*
Sulphur	0.062	Titanic acid	None.
Phosphorus	0.083	Carbon in carbonaceous matter	0.09
Iron, metallic	56.29	Hygroscopic water	2.04
		Water of composition	9.41
Silica	4.94	Total	100.197
Iron, protoxide	0.43		
Iron, peroxide	79.85	Per cent. of insoluble silicious matter	5.80
Alumina	1.69		
Manganese, protoxide	0.15	Silica	4.94
Lime	0.20	Alumina (with a trace of oxide of iron)	0.72
Magnesia	0.60	Magnesia	0.05
Iron, disulphide	0.116	Potassa	0.07
Potassa	0.07	Soda	0.03
Soda	0.03		
Carbonic acid	0.39	Total	5.81
Phosphoric acid	0.191		

b

c To the north of the old part of the mine one-eighth of a mile a new excavation has been made to a depth of 10 to 12 feet. Here the ore occurs disseminated through crushed strata of manganiferous ochreous clay. Most of it is in small fragments, but some lump-ore occurs, and this has a structure similar to that of 626 and 627. The ore from this excavation is used to supply Graham's new furnace.

628. Analysis: Iron, 56.43 per cent.; phosphorus, 0.033 per cent.; titanic acid, none; phosphorus ratio, 0.058. Sample taken from piles of screened ore ready for washing at the new excavation.

629. *Rich Hill.* Limonite. Three-fourths of a mile southwest of mouth of Little Reed Island creek. Owned by David Forney.

Two old excavations; abandoned and caved in; no ore in place to be seen. In a tunnel, without ore, near by, it is seen that the rock along the belt containing the ore-deposits is calcareous and ferruginous shale of various d colors. A part of this ore is "potty", the rest is cavernous, and similar in structure to 626, 627, and 628. Makes "neutral iron" for car-wheels, etc.

629. Analysis: Iron, 56.22 per cent.; phosphorus, 0.034 per cent.; titanic acid, none; phosphorus ratio, 0.060. Sample taken from a pile of lump-ore at the more easterly of the two pits.

632. *Panic* or *White Rock.* Limonite. Three miles west of Panic or White Rock furnace, on furnace property. Lobdell Car-Wheel Company.

Here a cut 6 feet wide and 15 feet deep has been made, following the ore in an approximately east and west direction for some 50 feet. Another cut 15 feet deep has been made just west of the first and at right-angles to it, without, however, striking any ore. The rock passed through is a decomposed brown, white, yellow, and gray shale. Dip nearly vertical. The ore appears to occur in an irregular mass or pocket. No solid rock is encountered in this e mine.

632. Analysis: Iron, 46.61 per cent.; phosphorus, 0.125 per cent.; titanic acid, small amount; phosphorus ratio, 0.267. Sample taken across 6-foot thickness of ore in the open cut, at distance of 12 feet from the surface.

Following is the complete analysis of sample 632:

	632.		632.
	Per cent.		*Per cent.*
Sulphur	0.056	Titanic acid	0.16
Phosphorus	0.125	Carbon in carbonaceous matter	0.02
Iron, metallic	46.61	Hygroscopic water	1.88
		Water of composition	10.28
Silica	11.47	Total	100.[illegible]
Iron, peroxide	66.52		
Alumina	5.42	Per cent. of insoluble silicious matter	13.10
Manganese, dioxide	3.46		
Lime	0.21	Silica	11.47
Magnesia	0.11	Alumina (with trace of oxide of iron)	1.50
Iron, disulphide	0.050	Lime	0.05
Nickel, sulphide	0.11	Magnesia	0.06
Cobalt, sulphide	Trace.	Phosphoric acid	0.004
Carbonic acid	0.08		
Phosphoric acid	0.284	Total	13.084

f

633. *Panic* or *White Rock*. Limonite and hematite. Two miles west of Panic furnace, on furnace property. a
Lobdell Car-Wheel Company.

Small excavation in hillside just started. The ore is disseminated in lumps and grains through the soil.

633. Analysis: Iron, 46.12 per cent.; phosphorus, 0.087 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.189. Sample taken from ore-pile at the excavation. It consists of screened ore.

631. *Glade*. Limonite. Seven miles east-southeast from Wytheville.

This mine has been worked in past years, and is now being reopened to supply, in part, Walton furnace. Several excavations have been made, though in these the ore is not now well exposed. A tunnel has lately been run into the hillside 60 feet without striking the ore. It is seen in this locality that the rock in the immediate vicinity of the ore is a ferruginous decomposed shale. This ore has been used for making "neutral iron". b

631. Analysis: Iron, 49.96 per cent.; phosphorus, 0.229 per cent.; titanic acid, none; manganese, some; phosphorus ratio, 0.458. Sample taken from pile of lump-ore just north of the mouth of the tunnel.

The deposits called Panic furnace and Glade occur on a west-southwest and east-northeast range, which lies 4 to 5 miles to the northwest of the Cripple Creek and New River range. The limestones and shales, in connection with which they occur, were regarded as of Canadian age by Professors William B. and H. D. Rogers, and were so laid down by them on section 25, *Geological Report on Virginia*. (See *The Virginias*, June, 1880, opposite page 93.)

624. *Semi-Magnetic*. Hematite and magnetite. Two miles west of Wytheville.

Two test-pits in sight of road, the deepest not over 10 feet in depth. Both contain an ore which consists of c
a skeleton of dark steel-gray magnetic ore, the interstices of which are filled with bright-red, earthy hematite. The deposit presents no regular structure, and no true walls, as the substance adjoining the ore is the yellowish brown and reddish clay which forms the soil. The prevailing rock in the vicinity is limestone, and a bed of flint crops out a few feet to the north of the ore. This ore has never been mined, and the quantity is uncertain.

624. Analysis: Iron, 58.30 per cent.; phosphorus, 0.027 per cent.; titanic acid, none; phosphorus ratio, 0.046. Sample taken from small piles of ore at two test-pits. Greatest thickness of ore exposed, 1½ feet.

This ore lies in a different range from either of those already mentioned as having been sampled in this division of the state. The rocks are laid down by Professors W. B. and H. D. Rogers on section 25, *Geological Survey of Virginia*, as belonging to Formation II (Canadian). (See *The Virginias*, June, 1880, opposite page 93.)

d

C.—James River Basin, West of the Blue Ridge.

WEST SLOPE OF THE BLUE RIDGE.

The deposits under this head are distinct beds, interstratified with the heavily-bedded sandstones of the western slope of the Blue Ridge. Professor J. L. Campbell (*The Virginias*, July, 1880, page 105) discusses the geological relations of these rocks, and concludes that they are of Primordial age. He gives also a geological section to show the relations of these ore-beds to the other rocks of the Blue Ridge. e

645. *Wood's Property*. Hematite. Four to 5 miles a little south of west from Buchanan, old stage-road to Buford's, on Dr. Wood's land.

This deposit has never been regularly mined, but has been quite extensively opened with a view to mining. Cross-cuts have been made for several hundred feet. It is a bedded deposit with a nearly vertical dip, the adjacent rocks being stratified beds of gray, compact sandstone. At the most northeasterly opening the deposit has a thickness of 15 feet; at the others it is 5 to 7 feet thick. In external appearance the ore is a ferruginous sandstone.

645. Analysis: Iron, 42.64 per cent.; phosphorus, 0.409 per cent.; titanic acid, none; phosphorus ratio, 0.959. Sample taken from outcrop of bed on roadside from cross-cut on ore-bed to northeast 200 feet, and from cross-cut on ore-bed to southwest 105 feet. This ore is very uniform in appearance.

644. *Arcadia Property*. Hematite (silicious). Stony creek, south-southeast from Buchanan, 3 miles (by the old f
stage-road to Liberty) up Stony Creek valley from the James river. On the Arcadia Iron property.

The old stage-road to Liberty runs southward along the west bank of Stony creek, and cuts across several bedded deposits of hematitic sandstone, or "specular" ore, as it is locally called. Of these, two have been opened directly on the roadside by open cut a short distance, and then 75 to 100 feet by drift along the strike of the bed. Here the beds dip only slightly to the southeast, and have a thickness of 2 to 4 feet, with an average of about 2½ feet. The ore is charged with silicious grains. About 5,000 tons of ore (it is estimated) have been mined at this locality, but none has yet been shipped.

644. Analysis: Iron, 44.06 per cent.; phosphorus, 0.462 per cent.; titanic acid, none; phosphorus ratio, 1.049. Sample taken across the 3-foot thickness of the bed in drift about 50 feet from road.

a 643. *Arcadia Property.* Hematite (silicious). South-southeast from Buchanan, up Stony Creek valley, 4 miles from James river (by old stage-road leading to Liberty). On tract of land known as the Arcadia Iron property.

Here a small ravine cuts through the bed, and on each side an excavation has been started in the direction of the strike of the beds (*i. e.*, northeast and southwest). The beds of sandstone with the interbedded ore exhibit sharp, local flexures (see sketches, Fig. 84). These local flexures prevent the general dip from being learned. Professor Campbell on the section (referred to above) gives the general dip of these beds as about 65° southeast.

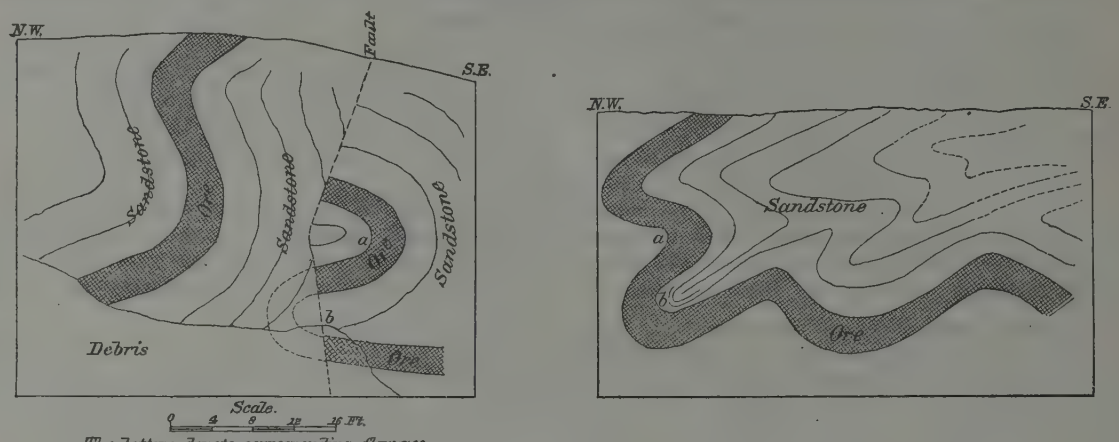


FIG. 84.—SKETCHES AT THE ARCADIA IRON PROPERTY, VIRGINIA.

By these two cuts the ore-bed has been opened for a length of about 200 feet. These excavations go about 25 feet below the surface, and are 30 to 40 feet wide. On account of the folding the amount of ore reached by this sized excavation is about 80 per cent. greater than if there had been no flexure. The thickness is 1 to 4 feet, and the average thickness about 2½ feet.

d 643. Analysis: Iron, 39.52 per cent.; phosphorus, 0.393 per cent.; TiO_2, none; phosphorus ratio, 0.994. Sample taken from large pile of ore at the two cuts mentioned above. It represented ore ready for shipment, but also represents the run of the ore-bed, since the ore-bed is very homogeneous, and could not be enriched much, if any, by sorting.

To the northeast a few hundred feet is another opening on the same bed; this was not sampled, the ore looking precisely similar to that which was sampled, and the thickness was about the same.

In going along the old stage-road up Stony creek, four beds of this ore are crossed on the Arcadia Iron property. Their aggregate thickness where the road crosses them is 10 to 12 feet. Only two out of the four were sampled, *i. e.*, the second and the fourth going southeast (see Professor Campbell's section).

e

WESTERN BASE OF BLUE RIDGE.

650. *Arcadia Iron Property.* Limonite. One and one-half miles northeast of Arcadia furnace, on the Arcadia Iron property.

The furnace and ore-bank were worked only a few months. The ore-pits are now fallen in, and scarce any ore is in sight at the ore-bank.

650. Analysis: Iron, 48.88 per cent.; phosphorus, 0.271 per cent.; titanic acid, small amount; Mn, small amount; phosphorus ratio, 0.554. Sample taken from small piles of ore at Arcadia furnace.

Professor J. L. Campbell (*The Virginias*, July, 1880, page 105) regards the bed of shale which contains this deposit as forming the upper member of the Potsdam. It is a common ore-bearing formation along the western
f base of the Blue Ridge (according to Campbell, W. B. Rogers, W. M. Bowson, and Frederick Prime, jr.).

PURGATORY AND MAY'S MOUNTAINS.

The iron-ore deposits of these two mountains are regarded by Prof. J. L. Campbell (*The Virginias*, October, 1880, page 156) as occurring in connection with the shales and sandstones of the Clinton formation.

646. *Retreat.* Limonite. Purgatory mountain, 3 miles southwest of Retreat furnace. Schultz property.

This bank is situated along the top and east side, near the top, of Purgatory mountain. The workings were quite extensive in the past, the ore being used in the Etna and Retreat furnaces at the eastern base of the mountain. Nothing has been done there for twenty years, and the workings, which were open cuts, are now in ruins.

646. Analysis: Iron, 53.35 per cent.; phosphorus, 0.555 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 1.040. Sample taken from piles of much weathered ore at several old open cuts at the Retreat bank.

647. *Carnes.* Limonite. Purgatory mountain, 4 miles north of Buchanan. Schultz property. **a**

Old excavation, now in ruins. No means of judging of the size of the deposit. The ore was formerly carted to the Etna furnace.

647. Analysis: Iron, 52.01 per cent.; phosphorus, 0.376 per cent.; titanic acid, none; phosphorus ratio, 0.723. Sample taken from a few lumps of weathered ore.

648. *Spengler.* Manganiferous limonite. South end of Round mountain, 4 miles north of Buchanan. Schultz property. Cross-cut, with a thickness of 2 to 3 feet of ore exposed.

648. Analysis: Iron, 29.59 per cent.; phosphorus, 0.031 per cent.; titanic acid, small amount; manganese, large amount; phosphorus ratio, 0.105. Sample taken from ore in cross-cut.

651. *May's.* Limonite. Five miles north of Buchanan, May's mountain west side. Schultz property. **b**

One small excavation in hillside. Ore never shipped or used in furnace.

651. Analysis: Iron, 56.19 per cent.; phosphorus, 0.045 per cent.; titanic acid, none; manganese, trace; phosphorus ratio, 0.080. Sample taken from small pile of ore at excavation.

649, 700, and 1001. *Hickory Hollow* or *Salisbury Furnace.* Limonite. Foot-hills west of May's mountain, about 1 mile northeast of Mr. Pursley's house, which is 1 mile north of Saltpeter cave.

Here a cut about 250 feet long has been made along the deposit in a nearly north and south direction, in some places to a depth of 40 feet, and the ore taken out. The ore in the upper part of the deposit, near the surface, is said to have been 20 to 25 feet thick. It is now about 8 feet thick in the bottom of the cut. The strata of buff, black, and white clay and soft shale, between which the ore body stands vertically, are very much crushed. **c**

A tunnel extends along the deposit some 40 feet lower than the bottom of the cut. In this tunnel the ore is said to be 6 to 8 feet thick. About 500 feet to the north of this cut, and in line with it, another opening had just been started. Here the deposit is seen to be 10 to 12 feet thick.

To the east of the main cut is a partially filled up pit 100 to 150 feet long, from which was taken in former years a large wedge shaped body of ore, which tapered downward and was 40 to 50 feet across at the top. This bank is the source of supply of Salisbury furnace, which is about 5 miles to the west-southwest.

700. Analysis: Iron, 40.17 per cent.; phosphorus, 0.287 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.714. Sample taken from ore-piles containing the lump-ore, which is taken from the main cut and the new opening. This ore is ready for the furnace. Thickness of deposit from which this came, 8 to 12 feet.

1001. Analysis: Iron, 38.64 per cent.; phosphorus, 0.273 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.706. **d** Sample represents the lump-ore from the new opening (*i. e.*, all that is taken from it), and both the lump and the fine ore from the tunnel under the main cut; the fine ore has been washed, and thus this sample represents the output of the mine as a whole.

649. Analysis: Iron, 50.94 per cent.; phosphorus, 0.111 per cent.; titanic acid, small amount; manganese, small amount; phosphorus ratio, 0.218. Sample from small piles of weathered ore at Salisbury furnace.

BRUSHY MOUNTAIN.

The coarse sandstones, with some shaly beds, in connection with which the iron-ore deposits of this region occur, are regarded by Professor J. L. Campbell, as of Oriskany age. (See *The Virginias*, January, 1880, p. 6.)

652, 653, and 654. *Longdale* (Lucy Selina furnace). Limonite. Four miles northeast of Lucy Selina (Longdale) **e** furnace. Belongs to Fironstone, Pardee & Co.

This bank was worked 40 years ago to supply a furnace which stood near the site of the present Lucy Selina furnace. The present workings consist of four open cuts along the same line. These cuts, with the intervals, cover a distance of about 1,600 feet. The ore has been stripped but not mined in the intervals between the cuts. This deposit has every appearance of being a distinct bed of ore, though not itself stratified. Its direction is north 35° east, and south 35° west; dip about 40° southeast. It varies in thickness from 10 to 30 or 40 feet, having an average thickness of 15 to 20 feet. About one-half the ore is solid, the rest coming out in a more or less broken and finely-divided state, and the two kinds of ore are used about half-and-half in the furnace. On the upper side of the deposit lies a bed of stiff bluish-gray clay, 3 to 8 feet thick. The same formation occurs, though to a less extent, upon the foot-wall. The country rock is grayish-brown sandstone and shale; in the immediate vicinity of **f** the deposit the latter is usually much softened and broken up by fissures (see section, Fig. 85). This mine is owned by the Longdale Iron Company, who are now building another furnace next to the old one, expecting, on its completion, to make with both 500 tons of gray forge-pig per week. The old furnace makes 28 to 30 tons per day. A narrow-gauge railroad runs from Longdale station, on the Chesapeake and Ohio railroad, to the furnace (8 miles), and then on 4½ miles farther, to the ore bank.

The hand-specimens 652, 653, and 654 do not represent the ore from different parts of the mine, but different types of ore which are liable to be found in any part. Hand-specimen 652 represents best the average character of the lump-ore.

652. Analysis: Iron, 51.66 per cent.; phosphorus, 0.463 per cent.; titanic acid, none; phosphorus ratio, 0.896. Samples taken across the 15- to 30-foot thickness on ore-faces in the four cuts.

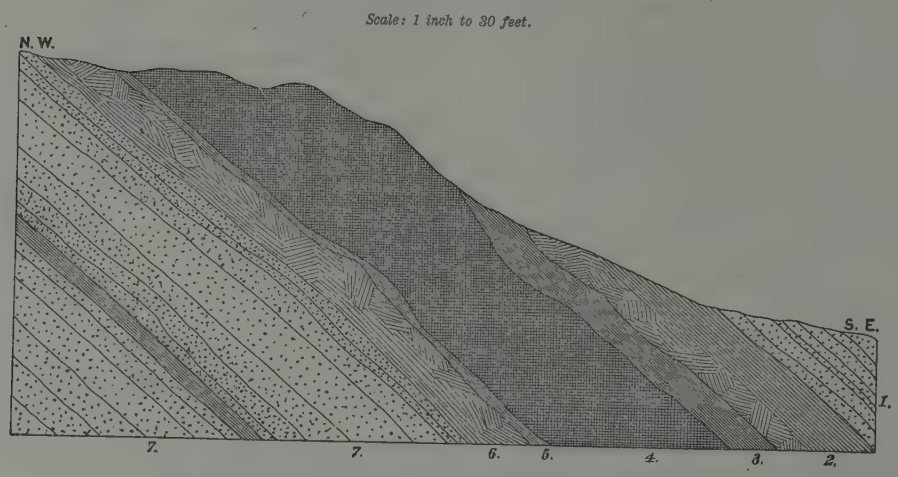
653. Analysis: Iron, 51.79 per cent.; phosphorus, 0.224 per cent.; titanic acid, small amount; manganese, trace; phosphorus ratio, 0.433. Samples taken from stock-pile (lump-ore), containing about 10,000 tons, near the furnace.

654. Analysis; Iron, 47.47 per cent.; phosphorus, 0.290 per cent.; titanic acid, small amount; manganese, trace; phosphorus ratio, 0.611. Sample taken from large pile of finely-divided ore near the furnace.

SECTION ACROSS THE

LONGDALE IRON-ORE DEPOSIT.

TAKEN ABOUT MIDWAY OF THE LENGTH OF THE OPENING



1. Coarse Sandstone.
2. Soft Shale, the beds of which, near the ore, are disturbed, and more or less crushed.
3. Stiff, bluish-gray clay.
4. Limonite Ore.
5. Stiff bluish-gray clay. Absent in some parts of the deposit.
6. Soft Shale; the beds much disturbed.
7. Coarse Sandstone.

FIG. 85.

Following is the complete analysis of sample 652:

	652		652
	Per cent.		*Per cent.*
Sulphur	0.104	Carbonic acid	0.07
Phosphorus	0.463	Phosphoric acid	1.060
Iron, metallic	51.66	Carbon in carbonaceous matter	0.07
		Hygroscopic water	0.91
Silica	9.97	Water of composition	10.51
Iron, protoxide	0.36		
Iron, peroxide	73.18	Total	100.315
Alumina	2.35		
Manganese, protoxide	0.56	Per cent. of insoluble silicious matter	11.64
Lime	0.22		
Magnesia	0.12	Silica	9.97
Iron, disulphide	0.205	Alumina (with trace of oxide of iron)	1.36
Zinc, oxide	0.37	Lime	0.02
Nickel, oxide	0.16	Magnesia	0.10
Cobalt, oxide	0.02	Potassa	0.18
Potassa	0.18	Total	11.63

RICH PATCH MOUNTAIN.

For a topographical map of Rich Patch mountain, with seven geological sections across it, at intervals of 1 to 2½ miles, by Professor J. L. Campbell, see *The Virginias*, December, 1880. On these sections the geological relations of the Medina and Oriskany ore-deposits which were sampled are shown.

657. *Clifton Forge.* Hematite (fossil). Cliff on east side of the gorge, through which Jackson river flows.

A drift has been run into Wilson's hill (a continuation of Rich Patch mountain), about 250 feet from the face of the cliff, in a northeast direction on the deposit, which is a stratified bed coincident with the other stratified

beds which form the anticlinal arch of this continuation of Rich Patch mountain. The drift being near the summit a of the arch the bed lies, at that point, nearly horizontal, though dipping a few degrees to the northwest. Along the southeast side of the drift the ore has been largely stoped out for a distance of 70 to 80 feet back from the drift, and the drift is being run still farther into the mountain. Numerous openings have been made on the outcrop of the bed along the face of the cliff, which show that the bed is pretty uniform in character. The thickness varies from 1 to 1½ feet, 2 or 3 inches of the thickness being made up of a red or brown shale-ore. (Hand-specimen, 657*b*.)

The ore-bed lies between heavy beds of white quartzite and sandstone above, and beds of shale or argillite below. (See Professor Campbell's geological section, next page.)

In *The Virginias*, January, 1880, p. 6, Professor Campbell states that the "red shale" and "fossil" ores mined b at Clifton forge are of Clinton Age; while in *The Virginias*, December, 1880, p. 188, right-hand column, 33 lines from the bottom, he quotes Professor W. B. Rogers' statement, that this ore-bed lies in the Medina sandstone, near the top, and implies that he agrees with Professor Rogers in his opinion.

The property belongs to the Charter Oak Life Insurance Company, of Hartford, Connecticut, and the ore is mined for the Quinnimont furnace.

657. Analysis: Iron, 41.71 per cent.; phosphorus, 0.444 per cent.; titanic acid, small amount; phosphorus ratio, 1.064. Sample taken from ore ready for shipment on cars (C. and O. R. R.). Came from the drift, about 200 feet from the entrance.

655. *Callie Furnace. Old bank.* Limonite. Southeast slope of Rich Patch mountain, one-quarter mile southwest from Callie furnace. Owned and managed by D. S. Cook. c

The workings upon this deposit consist chiefly of an excavation about 125 feet long, 60 feet deep, and 30 feet wide, extending along the deposit in a northeast and southwest direction. About 90 feet below the bottom of the excavation a tunnel was driven in from the southeast, striking (according to a miner's statement) the same deposit. This is now fallen in. On the northwest side the ore in cut has been removed, apparently, to its limits; but on the southeast wall there is still, in nearly vertical position, a layer of ore 6 to 8 feet thick. This ore is a mixture of a blackish limonite (of massive texture and coated on the fissures with a black, varnish-like substance), with an earthy-looking, impure brown limonite. This is the ore which has supplied Callie furnace in past years.

The sandstone, in connection with which this ore-deposit occurs, is regarded by Professor Campbell (*The Virginias*, January, 1880, p. 6) as of Oriskany age. (See, also, *The Virginias*, December, 1880, between pages 185 and 186, where, on Sections II and III, Professor Campbell illustrates his view of the relations of this deposit d to the other formations of Rich Patch mountain.)

655. Analysis: Iron, 45.62 per cent.; phosphorus, 0.067 per cent.; titanic acid, small amount; phosphorus ratio, 0.147. Sample taken from piles of somewhat weathered ore at the old ore-bank. Thickness of deposit probably 15 to 20 feet.

656. *Callie Furnace. New bank.* Brown shale limonite, 75 to 100 yards west of Callie furnace. D. S. Cook.

This bank is just started, and the intention is to supply the furnace with the ore which it affords. It is of the nature of an impregnation of the (nearly vertically dipping) shales and sandstones with limonite. This is apparently a lean ore. Thickness uncertain, but probably 3 to 5 feet of ore like the sample.

The intention of the furnace company is to put the furnace in blast as soon as the 5 miles of railroad which they are building, from the Chesapeake and Ohio railroad to the furnace, is completed. This railroad is already graded. The chief necessity for it is to bring coke to the furnace. e

656. Analysis: Iron, 25.26 per cent.; phosphorus, 0.095 per cent.; titanic acid, small amount; manganese, trace; phosphorus ratio, 0.376. Sample taken from 1,000 to 1,500 tons of ore from the "New bank", stored in the ore-house at Callie furnace.

658 and 659. *Lowmoor.* Limonite. Two miles south of Lowmoor station and furnace, which are on the Chesapeake and Ohio railroad. Mine and furnace belong to Lowmoor Iron Company.

The workings upon these deposits were begun about five years ago, and the ore which was mined was shipped to Quinnimont and Ferrol furnaces, to the former of which it has been shipped until quite recently.

The workings consist of five nearly parallel open cuts on different folds of the same ore-beds, situated on the northeast side of Fork run, and of four tunnels or drifts, one above another, on ore-bed on the opposite side of the run. (See map, Fig. 86).

The five open cuts are 20 to 50 feet deep, and show the ore-bed to be 10 to 30 feet thick. The tunnel marked f 6 on the map strikes the ore-bed 83 feet below the bottom of the cut above it, while the tunnel marked 7 strikes the ore 50 feet below the cut above it. These cuts are regarded by Mr. Wickes, the superintendent of the property, as being all upon one bed, which has been folded in such a way as to make it possible to mine a great quantity of ore without going to a great depth.

Below the bed is soft, gray clay or decomposed argillite, while above is a band of clay, and a quartzite or flint-rock in a fragmentary condition. This ore is somewhat silicious.

658. Analysis: Iron, 43.84 per cent.; phosphorus, 0.636 per cent.; titanic acid, none; phosphorus ratio, 1.451. Sample taken from pile of lump-ore, containing several thousand tons, which came from the five open cuts mentioned above. Ready for the furnace.

The four drifts (1, 2, 3, 4, on map) lie one above another all in the same bed of ore. This deposit is probably a different bed from that containing the open cuts, as it lies in a different line (though preserving the same direction),

a and the ore is of a slightly different character. The vertical distance from the lowest to the highest of these drifts is 142 feet, and the same bed outcrops at the surface of the hill above, at a height of 122 feet above the highest tunnel. The deposit is 10 to 20 feet thick. The ore is more ochreous and less silicious than that from the open cuts.

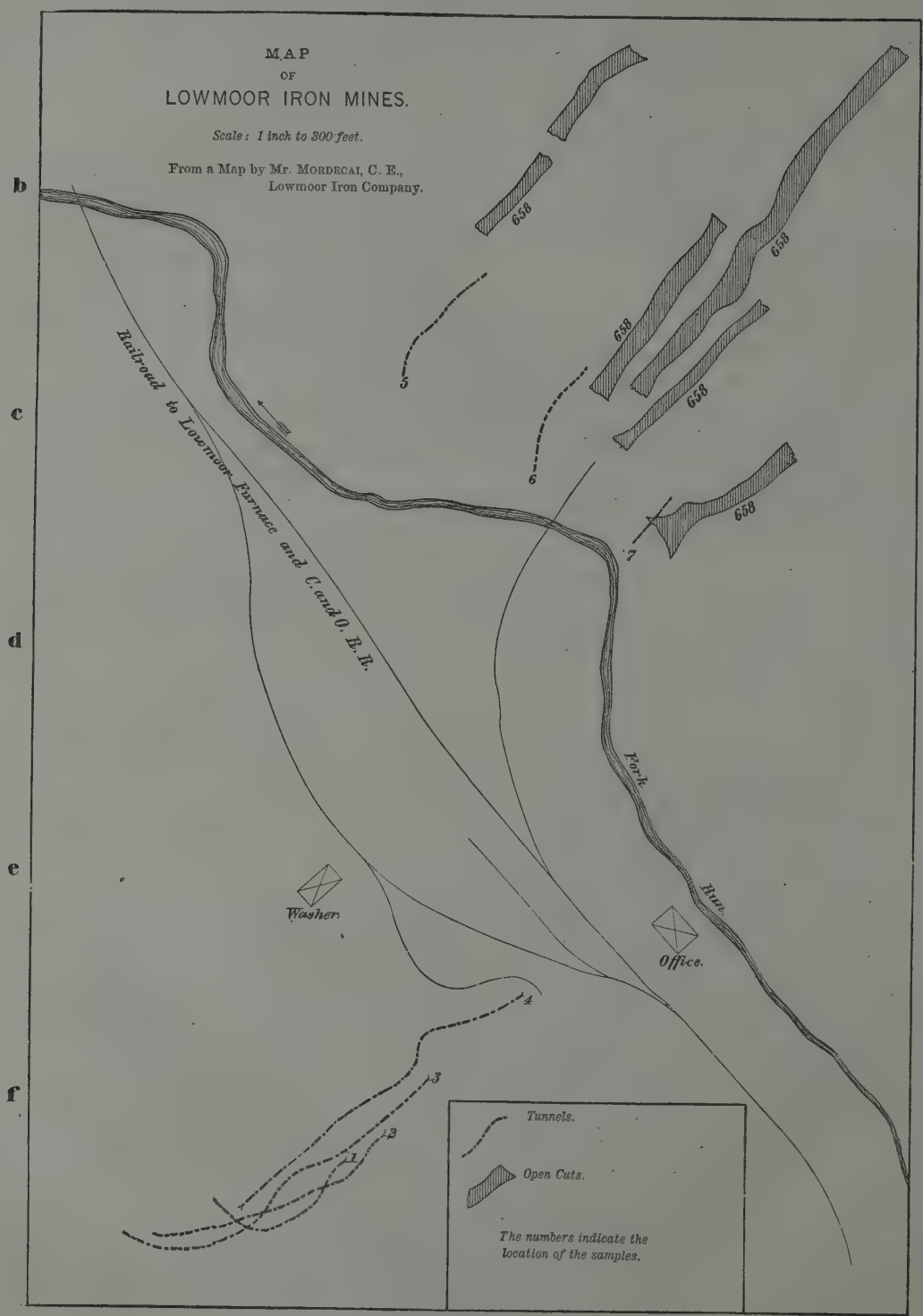


FIG. 86.

659. Analysis: Iron, 42.70 per cent.; phosphorus, 0.761 per cent.; titanic acid, none; phosphorus ratio, 1.782. Sample taken from several piles of ore ready for the furnace, which came from the four drifts just described. Lump and a small amount of washed ore included. a

Following are the complete analyses of samples 658 and 659:

	658.	659.
	Per cent.	*Per cent.*
Sulphur	0.007	0.007
Phosphorus	0.636	0.761
Iron, metallic	43.84	42.70
Silica	22.87	21.25
Iron, protoxide	0.54	0.27
Iron, peroxide	61.93	60.64
Alumina	1.78	3.71
Manganese, protoxide	0.05	0.19
Lime	0.13	0.04
Magnesia	0.05	0.26
Iron, disulphide	0.013	0.013
Zinc, oxide	0.35	0.16
Nickel, oxide	0.02	0.21
Potassa	0.14	0.06
Soda		0.03

	658.	659.
	Per cent.	*Per cent.*
Carbonic acid	0.07	0.11
Phosphoric acid	1.456	1.742
Carbon in carbonaceous matter	0.06	0.06
Hygroscopic water	0.93	1.46
Water of composition	9.54	9.55
Total	99.929	99.755
Per cent. of insoluble silicious matter	23.64	23.33
Silica	22.87	21.25
Alumina (with trace of oxide of iron)	0.62	1.81
Lime	0.01	0.03
Magnesia	0.05	0.13
Potassa	0.14	0.06
Soda		0.03
Total	23.69	23.31

b

c

The Lowmoor Iron Company have just built a 75-ton furnace (hot-blast, coke) at the junction of their ore railroad with the Chesapeake and Ohio railroad in order to use the ore from these deposits.

In *The Virginias*, January, 1880, page 6, Professor Campbell cites these deposits as belonging to the Oriskany formation, and in the December, 1880, number of the same journal, he shows (on Section No. IV, between pages 188 and 189) the relation of these beds to the other formations.

POTTS' CREEK.

d

Only outcrops observed. No mining has ever been done on this creek, or, so far as could be ascertained, within the area which it drains.

1009. *Outcrop on A. Given's land.* Limonite, silicious. Southeast side of Potts' creek, and about one-quarter mile east of A. Given's house, 20 miles southwest of Covington.

It is a ferruginous sandstone, the beds standing vertically and projecting above the other sandstones, which join it on each side. This outcrop is 12 to 15 feet thick, but only 5 to 6 feet of the thickness (so far as can be seen on the surface) is rich enough in iron to be called ore. This outcrop was traced with continuous thickness 200 to 250 feet up the hillside.

1009. Analysis: Iron, 31.97 per cent.; phosphorus, 0.164 per cent.; titanic acid, none; phosphorus ratio, 0.513. Sample taken across the outcrop, sampling only about 6 feet of the thickness, *i. e.*, the best of the ore. e

1009*a* and 1009*b* are hand-specimens from quite small outcrops on the farms of Mr. Robeson and Mr. Hamilton, Potts' creek, about 16 miles southwest from Covington.

WARM SPRINGS MOUNTAIN.

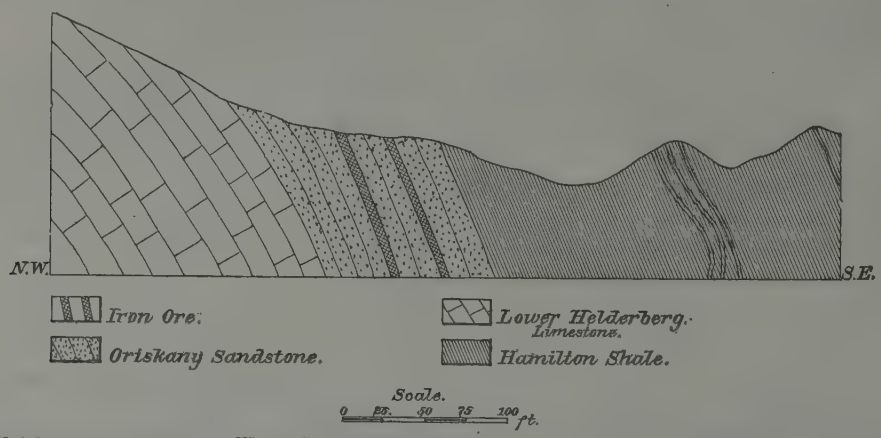
Professor J. L. Campbell (*The Virginias*, April, 1880, p. 55) gives a geological section of Warm Springs mountain through Warm Springs, Bath county, by which it appears that the Lower Helderberg limestone occurs along the southeast slope of that mountain near the base, dipping to the southeast. This formation is overlaid by the Oriskany sandstone, and this in turn by the Hamilton shales. A section observed near Covington, at the f southeast base of Warm Springs mountain, agrees with the supposition that this mountain, at least along its southeast base, contains the same succession of formations at this part as it does near Warm Springs, 20 miles to the northeast at the point where Professor Campbell's section crosses. (See section, Fig. 87.)

This section runs northwest and southeast; it is taken near Mr. Dickson's house, near the Chesapeake and Ohio railroad, west of Covington, in valley leading northeast. The bottom of the valley contains gray and black shales (Hamilton). Up the mountain side next to the shales, and dipping under them to the southeast, lies strata of coarse gray and brown sandstone, containing casts of *Rensselaria ovoides* (Oriskany). Above the exposures of sandstone and dipping under them come heavy beds of fossiliferous limestone (Lower Helderberg). The sandstone formation contains, interbedded, two deposits of rather lean iron ore, one 4 feet the other 5 feet thick.

a 1010. *Dolly Ann.* Limonite. Pounding Mill run, about 3 miles above (*i. e.*, northeast of) Dolly Ann furnace, which is at the southeast base of Warm Springs mountain, about 3 miles east-northeast of Covington.

Very little mining has been done at this locality, and that was many years ago. The ore and its accompanying sandstone make a cliff along the southeast side of the valley. On account of the *débris*, it cannot be seen exactly how the ore-bed dips, but it appears to dip about 50° to the southeast, that is, away from the axial line of the valley; thus it is difficult to estimate the thickness of the bed, but there appears to be a thickness of at least 12 to 15 feet of good ore. This outcrop extends at least 800 to 900 feet in length.

b



c

FIG. 87.—SECTION ON SOUTHEAST BASE OF WARM SPRINGS MOUNTAIN, IN VALLEY LEADING NORTHEAST FROM MR. DICKSON'S HOUSE ON THE CHESAPEAKE AND OHIO RAILROAD, WEST OF COVINGTON, VIRGINIA.

Judging from the position at the base of Warm Springs mountain and the lithological character of this ore, and the sandstone occurring with it, which are the same as those at the locality near Mr. Dickson's, the geological position is probably Oriskany.

d 1010. Analysis: Iron, 51.77 per cent.; phosphorus, 0.428 per cent.; titanic acid, trace; phosphorus ratio, 0.827. Sample taken across the 12-foot thickness of the deposit at about the middle of the exposure.

1011. *Wills'.* Limonite. One half mile southeast of the railroad station, Covington, on Mr. Wills' land.

At this mine is a loose deposit of limonite resting on and against the Upper Silurian limestone. No signs of stratification appear in it. It consists of fragments of ore scattered through a mass of sand and clay. The amount of lump-ore is inconsiderable. To obtain the fine ore all the material mined has to be screened. Several hundred tons of such ore have been obtained here and shipped to Buffalo Gap furnace.

1011. Analysis: Iron, 37.39 per cent.; phosphorus, 0.395 per cent.; titanic acid, trace; some manganese; phosphorus ratio, 1.056. Sample taken from 30 to 40 tons of screened ore at the ore-bank.

1003. *Smith-McAlister.* Limonite. One mile southeast of Covington, on Mr. McAlister's land. Leased and mined
e by Mr. Smith.

The only workings consist of a circular excavation on the top of the deposit, close to the surface. This excavation is about 20 feet across and 5 to 6 feet deep. Some 3-foot thickness of ore has been mined over an area of about 12 by 15 feet. The ore is being hauled 1½ miles to Covington and shipped to Lowmoor furnace.

1003. Analysis: Iron, 51.01 per cent.; phosphorus, 1.189 per cent.; titanic acid, none. Sample taken across the 15-foot thickness of the deposit.

1002. *Dickey.* Limonite. One mile north-northeast of Covington, on Burke's lands.

A tunnel has been run into the hillside about 60 feet, in ore all the way, and in a northerly direction. The deposit is about 12 feet thick, and dips 45° to the west. Mined to 15 feet below the surface. The whole deposit
f is in a fragmental state; hardly any lumps larger than a hand-specimen occur. The whole of the ore mined is screened, and about one-half is separated as good ore. About 200 tons of ore have been mined and shipped to Buffalo Gap furnace.

1002. Analysis: Iron, 45.24 per cent.; phosphorus, 0.216 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.477. Sample taken at head of tunnel across the 10 feet thickness of the bed.

PETERS' MOUNTAIN.

1007. *Gay & Lewis.* Limonite. Southeast side of Peters' mountain, about 4 miles southwest of Mud tunnel, and on the land of Mr. Hanes.

The ore deposit lies in a nearly horizontal position, dipping perhaps 10° to the southeast. It lies just at the surface, in one place being covered with 2 or 3 feet of white and buff clay.

Below it rests upon chert, and is seen to be 10 to 12 feet thick. Only a small excavation, say 20 by 30 feet, has been made, so that the extent of the deposit laterally cannot be ascertained. a

The ore is carted 4 miles to McDowell's switch, near Mud tunnel, on the Chesapeake and Ohio railroad, and shipped to Quinnimont furnace.

1007. Analysis: Iron, 39.96 per cent.; phosphorus, 0.436 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 1.091. Sample taken across the 10- to 12-foot thickness of the deposit from top to bottom, avoiding some bands of very silicious ore which is not shipped, and which are together about 3 feet thick, leaving 7 to 8 feet of ore sampled.

1008. *Huddleson.* Limonite. Southeast side of Peters' mountain, about 5 miles southwest of Mud tunnel, and on Mr. Huddleson's land.

The workings consist of several irregular excavations in the hillside. The ore-mass forms the top of a knoll, and the workings do not give any clue to the shape or limits of the deposit, since they are entirely in the ore. It b can only be said that it is 200 to 300 feet long, 60 to 70 feet wide, and 15 to 20 feet deep.

This, however, would not give the minimum of the amount of good ore, the mass being in general much too silicious to be considered paying ore. The good ore occurs in bunches mingled with the rest in so irregular a manner that it is impossible to estimate the proportion which the ore bears to the refuse. The whole of the ore-bearing material has to be handled in order to get at the material which will pay to ship, and it is only a small proportion which is of that quality. One-third of the ore shipped is lump and the other two-thirds fine ore.

Along the southeast side of the deposit is a belt of fine ore, which is being removed by a cut 9 feet wide, extending northwest into the hillside. The fine ore is screened, about one-third being screened out as refuse. c

The ore is carted 5 miles, chiefly down-grade, to McDowell's switch, near Mud tunnel, on the Chesapeake and Ohio railroad. The bank is managed by Messrs. Gay & Lewis, and the ore is sent to Quinnimont and Ferrol furnaces.

The hand-specimen 1008 represents the best of the ore.

1008. Analysis: Iron, 46.49 per cent.; phosphorus, 0.252 per cent.; titanic acid, small amount; manganese, small amount; phosphorus ratio, 0.542. Sample taken from two piles of ore ready for shipment at the bank. One pile contains about 10 tons of lump-ore, the other about 15 tons of fine ore.

1004. *Trice.* Limonite. Northwest side of Peters' mountain, 2 miles from Trice's switch, and on the land of Mrs. Kane. d

The ore-bed is 6 to 8 feet thick, and dips to the southeast about 30°. It is overlaid by brown and buff shales and underlaid by chert. A few hundred tons only have been mined here. The ore is hauled to Trice's switch, 2 miles distant, and thence shipped to Quinnimont furnace.

1004. Analysis: Iron, 32.24 per cent.; phosphorus, 0.525 per cent.; titanic acid, small amount; phosphorus ratio, 1.628. Sample taken from pile of about 50 tons of lump-ore, ready for shipment at the bank.

1005 and 1006. *Sadler* or *Stack.* Limonite. Northwest side of Peters' mountain, near Dunlap's creek, 2 miles from Dickson's switch, about 8 miles west of Covington, in an air line, and 11 miles by road from that place. On Mr. Stack's land.

The workings here consist of several open cuts on a northeast and southwest line. The cuts extend along the northwest slope of a hill adjoining Peters' mountain proper. They are entirely in the ore, and have cut into the deposit 40 to 60 feet laterally. The main cut is 120 feet long; then come, to the southwest, 55 feet along the deposit, where the ore has been only stripped and not mined. Then another cut 50 feet long. Two hundred and e fifty feet northeast of the main cut is another 40 feet long, and about 400 feet southwest of the second cut mentioned is another 60 feet long, so that the deposit has been proved for a length of about 1,000 feet. Not more than one-third of the ore is waste, and a large part of the waste is on account of its breaking up too fine in handling. The ore is pretty uniform in quality in all the cuts, and they are all similar in section to the main cut. The outcrop of the ore shows on both sides of all the cuts, and in places extends back 75 to 100 feet on the upper edge of the main cut. This ore is hauled 2 miles to Dickson's switch, on the Chesapeake and Ohio railroad. Ore has been shipped from this bank to Buffalo Gap, Ferrol, Lowmoor, and Quinnimont furnaces, but after this will probably be shipped wholly to Lowmoor.

1005. Analysis: Iron, 43.71 per cent.; phosphorus, 0.462 per cent.; titanic acid, none; some manganese; phosphorus ratio, 1.057. Sample taken across the deposit on face of ore at end of main cut. f

1006. Analysis: Iron, 43.71 per cent.; phosphorus, 0.380 per cent.; titanic acid, small amount; phosphorus ratio, 0.869. Sample taken from 300 tons of lump-ore ready for shipment at the ore-bank, from the main cut, where the work is now going on.

The four banks just described lie along the base of Peters' mountain; the Gay & Lewis and the Huddleson bank along the southeast base, and the Trice and Sadler's along the northwest base. Peters' mountain is a continuation to the southwest of Warm Springs mountain, and as these ore-deposts lie in an analogous position to those at the base of Warm Springs mountain, which were found to belong to the Oriskany formation, it seems probable that these deposits also are of that age.

a

D.—Shenandoah Valley.

WESTERN BASE OF THE BLUE RIDGE.

The iron ore deposits of this region are described by Professor J. L. Campbell as occurring in a thick bed of shale which forms the upper member of the Potsdam formation, and which immediately underlies the valley limestone (Calciferous). (See *The Virginias*, January, 1880, p. 4, and March, 1880, p. 43.)

663. *Kennedy.* Limonite. One-quarter mile west of Kennedy furnace site. Southeast part of Augusta county.

b Ores not worked for many years, but formerly used to supply Kennedy and Mount Torrey furnaces. The Kennedy furnace has entirely disappeared. Banks filled in and overgrown.

663. Analysis: Iron, 52.50 per cent.; phosphorus, 0.229 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 0.436. Sample taken from small piles of much weathered ore at the ore-bank.

664. *Mount Torrey* or *Virginia.* Limonite. One mile west of Mount Torrey (Virginia) furnace. Southeast part of Augusta county. Owned by John Wissler & Son.

Open cut running nearly east and west (the Blue Ridge having locally that trend). Length about 125 feet; depth, 30 feet. It has not been worked for two years, and has now fallen in, so that little ore is to be seen in place. The ore was used to supply Mount Torrey furnace. The decomposed shale stands here about vertical; the thickness

c of the deposit can not be determined, though it is probable that a large amount of ore has been obtained.

654. Analysis: Iron, 45.34 per cent.; phosphorus, 0.206 per cent.; titanic acid, none; phosphorus ratio, 0.454. Sample taken from piles of ore ready for use in the furnace at the ore-bank.

673. *Miller.* Limonite. One mile south-southwest of Mount Vernon furnace. Southeast part of Rockingham county.

This bank has not been worked for several years, and has caved in to such an extent that none of the ore in place is now exposed. The ore was mined from an excavation of circular form, 150 to 200 feet across and 40 to 50 feet deep. This ore was used to supply Mount Vernon furnace.

673. Analysis: Iron, 45.41 per cent.; phosphorus, 0.274 per cent.; titanic acid, small amount; manganese, small amount; phosphorus

d ratio, 0.603. Sample taken from pits of fine ore at Miller ore-bank.

674. *Raines & Weaver.* Limonite.

674. Analysis: Iron, 51.30 per cent.: phosphorus, 0.103 per cent.; titanic acid, small amount; phosphorus ratio, 0.201. Sample taken from piles containing several hundred tons of lump-ore at Mount Vernon furnace. The ore is a mixture of the ore from the two banks, the two sorts of ore being just alike in appearance.

Following is the complete analysis of sample 674:

e

	674.		674.
	Per cent.		*Per cent.*
Sulphur	0.004	Carbon in carbonaceous matter	0.15
Phosphorus	0.103	Hygroscopic water	0.67
Iron, metallic	51.30	Water of composition	9.89
		Total	99.835
Silica	9.68		
Iron, peroxide	73.28	Per cent. of insoluble silicious matter	11.18
Alumina	2.43		
Manganese, protoxide	0.15		
Manganese, dioxide	2.84	Silica	9.68
Lime	0.07	Alumina (with trace of oxide of iron)	1.38
Magnesia	0.22	Lime	0.07
Iron, disulphide	0.008	Magnesia	0.10
Nickel, oxide	0.14	Phosphoric acid	0.020
Carbonic acid	0.07	Titanic acid	Trace.
Phosphoric acid	0.237	Total	11.25
Titanic acid	Trace.		

f

674. *Raines.* Limonite. Four miles north-northeast of Mount Vernon furnace. Southeast part of Rockingham county. Mount Vernon Iron-Works Company, lessees.

The workings consist of an open cut 700 feet long, 20 to 50 feet wide, and 10 to 25 feet deep, running north 35° east. Ore occurs with shale, dipping only a few degrees to the northwest. Ore formerly used to supply Mount Vernon furnace. Cut caved and washed in, so that ore in place can not well be observed. The Weaver bank is a similar cut, just to the northeast of this one. It was not sampled separately, though the ore from the two was sampled together at Mount Vernon furnace.

675. Analysis: Iron, 41.15 per cent.; phosphorus, 0.231 per cent.; titanic acid, small amount; manganese, small amount; phosphorus ratio, 0.561. Sample taken from washed-ore piles at Raines' bank.

665, 666, 667, and 668. *Fox Mountain, Shenandoah Iron-Works.* Limonite. One-quarter mile southwest of Furnace No. 2, belonging to the Shenandoah Iron-Works. a

This deposit has been worked for about twenty years. The workings consist mainly of one large pit about 275 feet long, 150 feet wide, and 50 feet deep, running about north and south. At the bottom a tunnel extends from the west side in a westerly direction 175 feet. This tunnel is 10 feet wide and 10 feet high, is driven all the way in ore-bearing material, and is still being driven farther in a westerly direction. Two shorter tunnels of the same height and width extend in the same direction, one on each side of the main tunnel. The whole of the material in which these workings have been made is ore-bearing. It is a stratified deposit, the beds lying nearly horizontal, though showing local crumplings. The deposit consists of a great number of thin beds (one quarter inch to 3 or 4 inches) of ocher and soft ferruginous shale and clay, of colors varying from light yellow to brown and black, with very thin layers of limonite interlaminated. A few layers, several inches thick, of limonite and manganiferous limonite occur, but these form a very insignificant proportion of the whole. b

The whole deposit is mined, screened, and about one-half saved as good ore; of this the coarser part is roasted, and the finer is washed and roasted before being used in the furnace. The prepared ore thus obtained is all used in "Furnace No. 2" of the Shenandoah Iron-Works (William Milnes, jr., lessee), the pig being made into charcoal-blooms for boiler-plates at the forge of the iron-works, near Shenandoah Iron-Works post-office.

The hand-specimen 665 represents what little lump-ore there is in the deposit, while the samples 665, 666, 667, and 668 represent different stages of the preparation of the ore for the furnace.

665. Analysis: Iron, 41.17 per cent.; phosphorus, 0.215 per cent.; titanic acid, small amount; phosphorus ratio, 0.523. Sample taken from ore in the main tunnel. Raw, screened.

666. Analysis: Iron, 46.29 per cent.; phosphorus, 0.166 per cent.; titanic acid, small amount; phosphorus, ratio, 0.359. Sample taken from large pile of fine ore at the washer near the ore-bank. Screened and washed. c

667. Analysis: Iron, 43.96 per cent.; phosphorus, 0.078 per cent.; titanic acid, small amount; phosphorus ratio, 0.177. Sample taken from pile of fine ore at the kiln near furnace. Screened, washed, and roasted.

668. Analysis: Iron, 49.25 per cent.; phosphorus, 0.224 per cent.; titanic acid, small amount; phosphorus ratio, 0.455. Sample taken from a pile of the coarser ore in the ore-house near the furnace. Screened and roasted.

Following is the complete analysis of sample 665:

	665.		665.
	Per cent.		*Per cent.*
Sulphur	0.010	Titanic acid	Trace. d
Phosphorus	0.215	Hygroscopic water	1.27
Iron, metallic	41.17	Water of composition	11.28
		Total	99.837
Silica	20.03		
Iron, peroxide	58.69	Per cent. of insoluble silicious matter	25.15
Alumina	6.71		
Manganese, protoxide	0.62	Silica	20.03
Manganese, dioxide	0.32	Alumina (with trace of oxide of iron)	5.05
Lime	0.17	Lime	0.10
Magnesia	0.09	Magnesia	0.02 e
Iron, disulphide	0.019		
Carbonic acid	0.14	Total	25.20
Phosphoric acid	0.498		

MASSANUTTON MOUNTAIN.

In *The Virginias*, March, 1880, p. 35, Frederick Prime, jr., states that the iron-ore deposits of Massanutton mountain are contained in the slates and shales of the Clinton formation.

670. *Three Top Mountain.* Limonite. Two miles north of Mine run, or Boyer's furnace, Massanutton mountain.

This bank, as well as the furnace, has been abandoned for several years, and the workings are fallen in. A large quantity has been mined and brought to Mine Run furnace. f

670. Analysis: Iron, 43.78 per cent.; phosphorus, 0.153 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.349. Sample taken from two large piles of lump-ore at Mine Run furnace.

NORTH MOUNTAIN.

This mountain lies along the northwestern part of Augusta and Rockbridge counties, but east of Mill mountain, which is a continuation (to the northeast) of Rich Patch mountain. The deposits which were sampled belong, according to Professor J. L. Campbell, to the Oriskany formation (see *The Virginias*, January, 1880, p. 6).

a 661 and 662. *Grace*, formerly *Ferrol*. Limonite and hematite. Three-quarters mile southeast of Elizabeth, Ferrol, or Grace furnace, which is on the Chesapeake and Ohio railroad. Belongs to Pennsylvania and Virginia Iron and Coal Company.

Mining was begun here eighteen years ago by the Confederate government. The workings consist of an excavation running for about one-quarter mile in a northeast and southwest direction along the northwest side of a hill at the northwest base of North mountain. The rocks (soft slate and soft sandstone) dip 40° to the southeast, and the ore-bed appears to be coincident with the other stratified beds. It outcrops along the hillside with a variable thickness, averaging 10 to 12 feet. The ore is largely in a soft, fragmental state, but contains bands of hard limonite from 1 to 2 feet thick, and also a bed of soft red shale or earthy hematite ore, 2 to 3 feet thick, b at certain parts of the outcrop. A tunnel is being driven in to strike the ore-bed 100 feet below the outcrop.

661. Analysis: Iron, 46.19 per cent.; phosphorus, 0.289 per cent.; titanic acid, small amount; phosphorus ratio, 0.626. Sample taken to show the output of the mine from two car-loads of limonite ore ready for shipment to Quinnimont, the Grace furnace not being in blast at the time.

662. Analysis: Iron, 29.87 per cent.; phosphorus, 0.246 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.824. Sample taken from 15 to 20 tons of the red-shale ore at the furnace, ready for use in the furnace. The bed of this ore was not well exposed at the time.

660. *Buffalo Gap*. Limonite. One-half mile north-northeast from Buffalo Gap furnace, which is on the Chesapeake and Ohio railroad. Belongs to the New York and Virginia Iron and Coal Company.

c The workings consist of an open cut, 75 feet long, running in a northeast and southwest direction, from the northeast end of which a tunnel runs northeasterly without yet striking any more ore. Some thousands of tons of ore have been taken from the cut, but the ore-deposit seems to come to an end near the mouth of the tunnel.

660. Analysis: Iron, 41.51 per cent.; phosphorus, 0.310 per cent.; titanic acid, none; manganese, small amount; phosphorus ratio, 0.747. Sample taken from pile of lump-ore, ready for use in furnace, at the ore-bank, as the thickness of the deposit is not well exposed.

GREAT NORTH MOUNTAIN.

This mountain runs along the northwest border of Shenandoah county, in a north-northeast and south-southwest direction. Professor J. L. Campbell gives a section showing the structure of the southern continuation of this mountain and the relations of its ore-beds, 12 miles to the southeast of Liberty Furnace bank (one of those sampled), d by which it appears that the ores of this mountain are of Upper Silurian age (*The Virginias*, September, 1880, p. 140).

671. *Old Bank, Liberty Furnace*. Limonite. One-half mile north of Liberty furnace. Belongs to John Wissler & Son.

First worked fifty years ago. Present workings begun five years ago. They consist of an open cut about 400 feet long, 10 to 50 feet wide, and 10 to 60 feet deep. Direction, north 15° east and south 15° west.

The deposit consists of a succession of ferruginous shales and clays of various colors, standing vertical with a number of intercalated beds of hard limonite and a little red-shale ore. The proportion of good ore in the deposit is very variable. Thickness of the part mined varies from 10 to 20 feet, and it is said that about two-thirds is good e ore. This ore is used, in connection with 672, to supply both Liberty and Columbia furnaces.

671. Analysis: Iron, 41.71 per cent.; phosphorus, 0.114 per cent.; titanic acid, small amount; phosphorus ratio, 0.273. Sample taken from pile of several hundred tons of lump-ore ready for use at the furnace.

672. *Hollow Bank, Liberty Furnace*. Limonite. One-half mile north-northeast from Liberty furnace. Owned by John Wissler & Son.

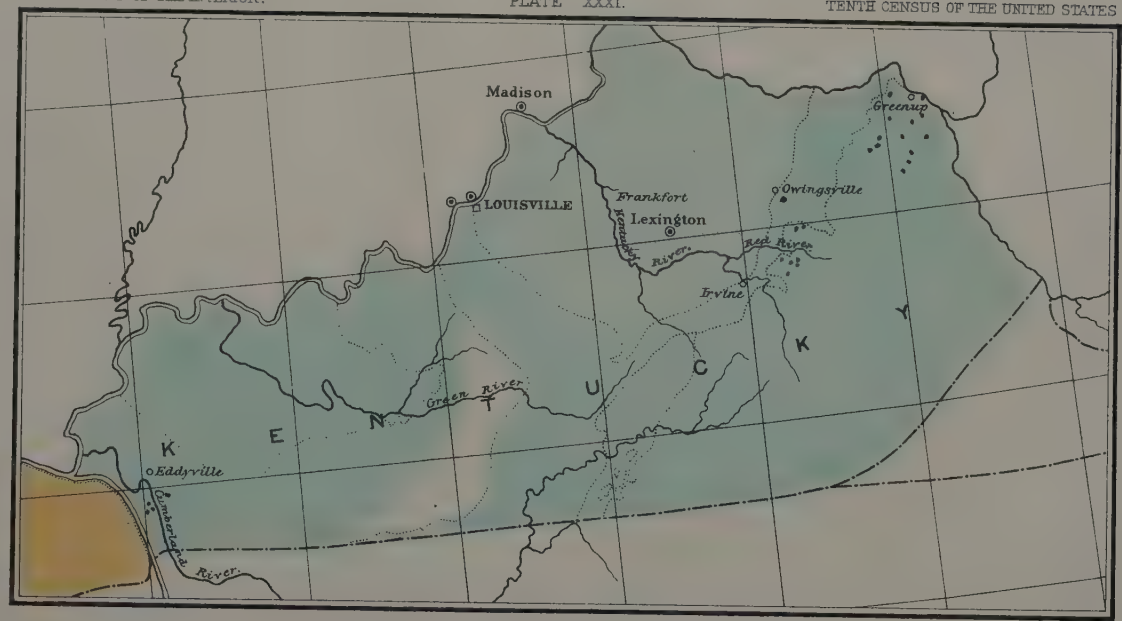
Open cut, about 175 feet long and 5 to 10 feet deep, running north 20° to 30° east. In same line, to north-northeast, three shafts have been sunk, 30 feet, 75 feet, and 45 feet, respectively, in depth. The structure of the deposit is similar to that of 671, though there is a larger proportion of hard ore. The deposit here is 3 to 5 feet thick. This ore is used, in connection with 671, to supply Columbia and Liberty furnaces.

672. Analysis: Iron, 43.90 per cent.; phosphorus, 0.076 per cent.; titanic acid, small amount; phosphorus ratio, 0.173. Sample taken
f from piles of lump-ore at Liberty furnace from Hollow bank.

669. *West Bank, Van Buren Furnace*. Limonite. One and one half mile southwest of Van Buren furnace, on the southeast slope of Paddy mountain, an offshoot from Great North mountain. Belong to Frank King.

Mining was begun here eleven years ago, but none has been done in the last seven years until six months ago. The present workings consist of a tunnel, 300 to 400 feet long, running into the hillside in a westerly direction. The deposit consists of a great number of crumpled strata of softened ferruginous shales, white, pink, yellow, and brown, with numerous thin layers of limonite intercalated. Dip very variable, but the strike is about north-northeast and south-southwest. The ore is used for supplying Van Buren furnace. Thickness very variable; from 2 to 5 feet of good ore.

669. Analysis: Iron, 35.26 per cent.; phosphorus, 0.066 per cent.; titanic acid, small amount; some manganese; phosphorus ratio, 0.187. Sample taken from pile of lump-ore ready for the furnace, at the ore bank.



Julius Bien & Co. Lith.

IRON ORE SAMPLE MAP OF KENTUCKY.

Geology generalized from a preliminary Map of the Kentucky Geological Survey.

Tertiary &c. | Coal Measures | Sub-Carboniferous Ls. | Upper Silurian & Devonian. | Siluro-Cambrian. | Iron ore deposits sampled.

Scale.

0 10 20 30 40 50

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN KENTUCKY.

By W. M. Chauvenet.

The iron ores of Kentucky at present mined come from three principal regions, which may be divided as follows:

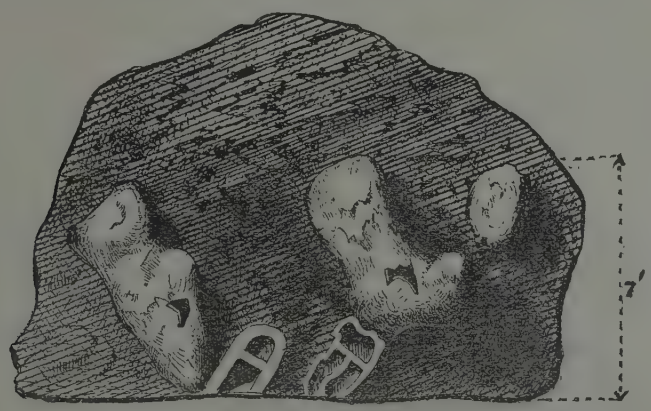
The Cumberland River region of Lyon and Trigg counties, in the southeastern part of the state:

The Kentucky and Red River region, including the Bath county ores: c

The Hanging Rock region.

The ores of the first-mentioned region are limonites associated with chert in red clay, occurring above the sub-Carboniferous limestone. The ores of the Kentucky and Red River region are the carbonate ores, known as the lower limestone ore, and resting upon the sub-Carboniferous limestone and a single deposit of limonite in the Clinton group at the Old Slate bank in Bath county. The ores of the Hanging Rock region are the carbonates, and limonites altered from carbonates, occurring at several well-defined horizons in the Coal Measures. The limonites of southwestern Kentucky are represented by the samples taken in Trigg and Lyon counties. These ores are worked for use in Center furnace, situated 2 miles west of the Cumberland river, in the extreme south of Lyon county. The ore is a hard, dense limonite, varying in form from small angular solid fragments to huge hollow d boulders, and broken pots imbedded in red clay, through which are also scattered loose angular fragments of white and yellow chert. It shows no approach to regular bedding, though the main ore-mass seems to follow the crown of the ridge, which here trends northeast. No system is followed in the mining of the ore. It is dug in open pits and underground burrows, which in some instances are extended into large chambers lighted by openings in the arched roof, or by irregular breaks and tunnels into neighboring open pits. In such cases a small tram-car is run through into the chamber for conveying the ore to the outer air.

e



f

Fig. 88.—Pots of limonite in red clay with chert.

The first sample was taken from the *School-house* bank, situated three-quarters of a mile northwest of Center furnace. The deposit here is remarkable for the great number of large hollow boulders and irregular pots, often 10 feet in diameter. The accompanying cuts (Figs. 88 and 89) were drawn from the working-faces in the School-house bank, and show some of the irregular ore-pots in place.

The cavities are often filled with red and white clay, and at times with water. The *Fulton* bank, half a mile from the School house bank, is a large open cut. The ore is in dense lumps and angular fragments, showing few

a hollow pots, and much more soft, red clay. It is more brittle and has a cherty fracture. Samples from the two above-mentioned banks were taken with a view to showing the difference between the pot-ore and that which occurs

b

FIG. 89.—POTS AND BOULDERS OF LIMONITE IN RED CLAY WITH CHERT.

in dense angular fragments. Though there is little difference in the percentage of iron, the variation in phosphorus is strikingly shown in the following analyses:

c

	589.	590.
	Per cent.	*Per cent.*
Metallic iron	49.23	48.03
Phosphorus	0.099	0.273
Phosphorus ratio	0.201	0.568

Sample 589 is the pot-ore from the School-house bank, while sample 590 is the dense ore from the Fulton bank.

The *Center* bank, *No.* 2, one-half mile northwest of the furnace, was worked, when visited in June, 1880, in one of d the large underground chambers above described, reached by a tunnel some hundred feet in length, and lighted by one opening in the top and a second high upon one side. The sample was taken on the northeast side of the room, at a depth of about 30 feet from the surface. The ore showed a rich vermilion coating, and the sample was taken especially to include this. The body of the ore is, however, of a dark liver color, occurring in rough masses and contorted ledges. This bank was first opened in 1840. The sample does not show any decided difference on account of the red coating, which is probably nothing more than oxide of iron. The ore gives, upon analysis—

e

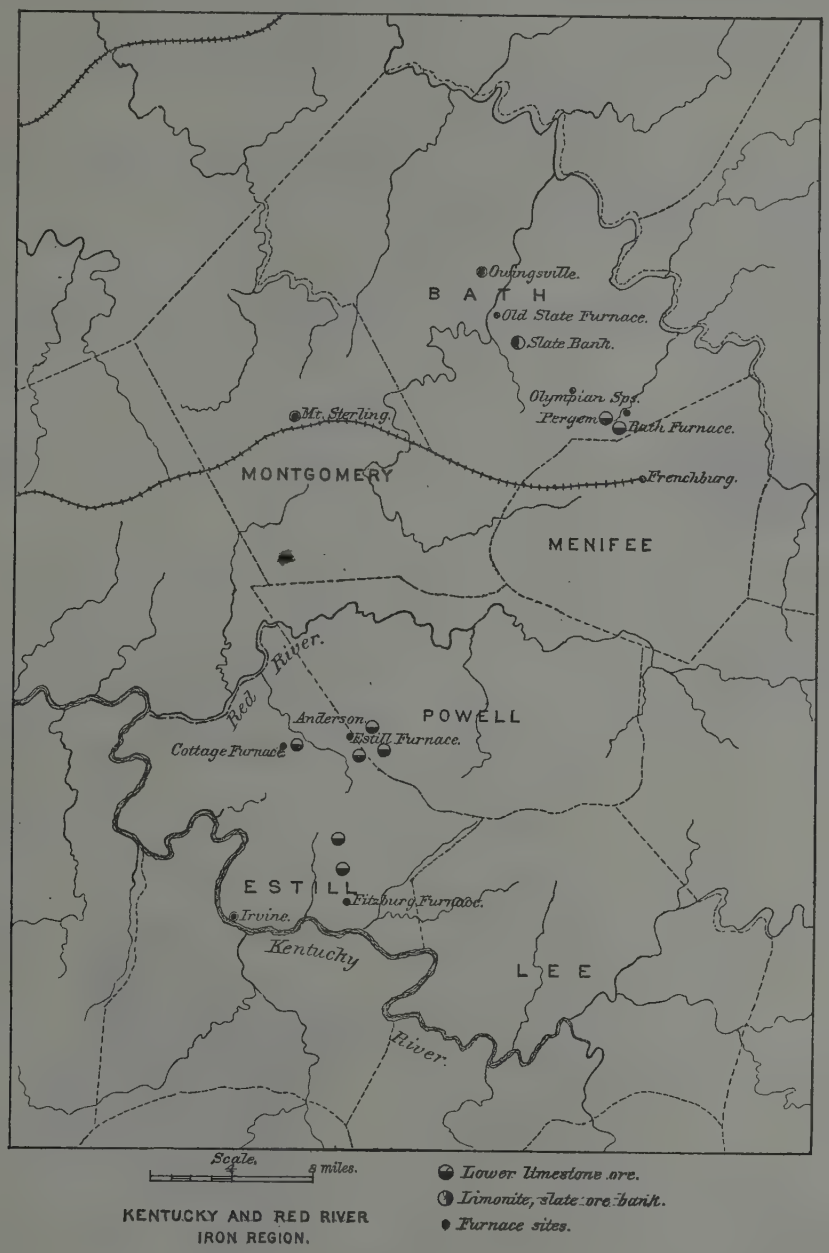
	591.
	Per cent.
Metallic iron	47.25
Phosphorus	0.120
Phosphorus ratio	0.254

The ores seen in Lyon county are much more free from inclosed chert than those of the same formation found farther up the Cumberland river, in Tennessee, and described under the ores of that state. The pots are here often lined with a black coating, and the associated clays show frequent sheets of mica. Crossing the Cumberland river into Trigg county, the ore has been extensively worked at *Trigg furnace*, 5 miles east of the river and northeast of Cadiz. The ore-banks, 1 mile northeast of the furnace, have been worked in several large open cuts in the hillside, which, when visited, were much fallen and covered, and flooded in the deeper portions by recent rains. These f banks were abandoned in 1876, when Trigg furnace was blown out.

A sample was collected from such loose lumps as could be found in the pits, and was taken from dense and honeycombed varieties alike, showing, upon analysis—

	592.
	Per cent.
Metallic iron	48.81
Phosphorus	0.104
Phosphorus ratio	0.213

The ores of the Clinton group, in Kentucky, are represented at only one locality, the Old Slate Furnace bank, in Bath county. (See the map of the region, Fig. 90).



KENTUCKY AND RED RIVER IRON REGION.

FIG. 90.

The Old Slate furnace was the first in the state, and was built in 1791. It is situated on Slate creek, 5 miles south of Owingsville, on the road to Olympian Springs. That portion of the bank from which the ore was taken is known as the *Block-house* bank, and is 1½ mile south of the furnace on the same road. The bank covers two or three low hills, and, though now abandoned, the pits and diggings from which the ore was formerly taken are seen on either side of the road and in the adjoining fields. The ore is an altered red hematite which, in its general appearance, seems related to the Dyestone group. It is a limonite, at times quite hard and compact, at times porous and fossiliferous, and of a reddish brown color. It is similar in texture and occurrence to the ore found near the Marion furnace, in Wayne county, Tennessee.

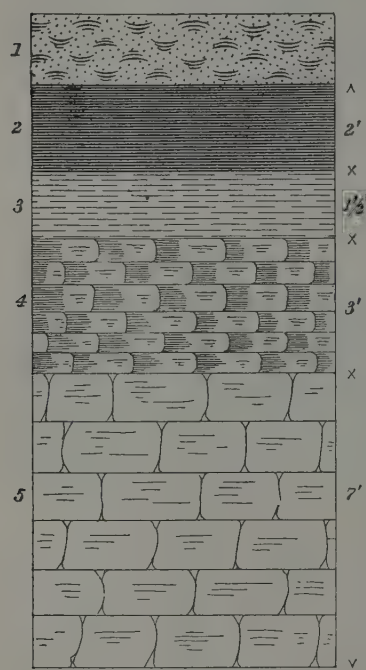
a The sample was drawn from lumps of ore scattered through the fields and from old dump-piles near the diggings, and gives, upon analysis—

	585.
	Per cent.
Metallic iron	51.58
Phosphorus	1.094
Phosphorus ratio	2.121

The carbonate ores occurring in the Coal Measures of eastern Kentucky are mined as far west as Bath, Powell, and Estill counties, the bed there worked, however, being only the lowest in the series, known as the lower limestone b ore, and resting upon the sub-Carboniferous limestone.

Bath furnace, 6 miles southeast of Olympian Springs, in Bath county, is one of two furnaces at present in blast in this middle iron region.

The principal ore-banks are situated from 2 to 4 miles from the furnace farther up the creek. The ore is found outcropping near the crowns of the ridges on either side of the stream-bed, and is worked by benching in open cuts. The ore-bed is from 2½ to 3 feet in thickness, as seen at the *Pergem* bank, where the section shown (Fig. 91) was taken. The ore occurs in jointed layers and blocks, the interior of which is unaltered carbonate, while the outer layers are much changed to limonite.



1. *Clay.*
2. *Black slate.*
3. *White shale.*
4. *Limestone ore.*
5. *Sub.Carb. limestone.*

FIG. 91.

Two samples were here taken, No. 583 from the Pergem bank, No. 584, an c average sample, from the stock-pile at the furnace. These samples show, upon analysis—

	583.	584.
	Per cent.	*Per cent.*
Metallic iron	50.65	44.51
Phosphorus	0.183	0.282
Phosphorus ratio	0.361	0.634

d This result shows the advantage to be gained by careful selection of ores.

The Red River iron-works include Estill, Fitzburg, and Cottage furnaces, all situated between the Red and Kentucky rivers, in Estill county. The preceding map shows their location.

Of these, Estill furnace alone was in blast when the region was visited. The ore bed from which the furnace is supplied is the same as that described in Bath county, namely, the lower limestone bed of the carbonate ores. The furnace is situated in the northern part of e Estill county near the Powell county line.

The *Anderson* bank is half a mile northeast of the furnace. The ore is a carbonate in all stages of alteration, from a blue ferruginous limestone, deep upon the bed, to a true limonite on exposed and weathered surfaces. The accompanying section (Fig. 92) was taken at the only opening on the f Anderson bank, and represents the working-face at the head of a short tunnel upon the ore-bed. The tunnel had reached a depth of 20 feet from the outcrop, and at this distance the ore-mass had much the appearance of an unaltered limestone, having a pale-blue fracture and streak. Its thickness is variable, and the upper portion of the bed more altered than that resting directly upon the underlying limestone. The cavities in the ore-mass, marked *a*, *a*, *a* in the cut, were filled with yellow and gray clay; those marked *c*, *c*, *c* were lenticular in shape, and surrounded by a somewhat altered liver-colored ore.

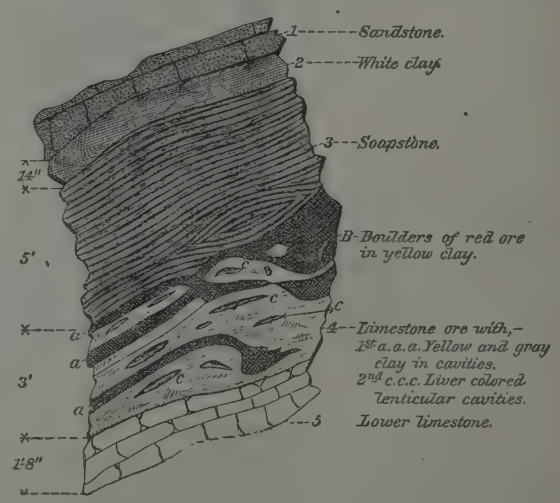


FIG. 92.

The sample taken at the point above described comes from the whole thickness of the bed at the head of the tunnel, and is known as the "blue ore".

A second sample was taken from a small prospecting pit, sunk upon a shoulder of ore some hundred feet a southeast of the above opening.

This pit exposes a much altered portion of the bed, and shows a limonite in hollow concretions, the cavities often filled with a scoriaceous sandy material, resembling the silicious porous cinder from a charcoal furnace.

The sandstone shown in Fig. 92 here dips directly upon the ore-bed, accounting partly for its greater alteration. This ore is known as the "red ore", and is compared with the blue ore above mentioned in the following analysis:

	586.	587.
	Per cent.	*Per cent.*
Metallic iron	34.94	47.51
Phosphorus	0.273	0.181
Phosphorus ratio	0.781	0.381

b

No. 586 is the "blue ore". No. 587 is the "red ore".

The result exposed well the nature of the unaltered ore deep upon the bed.

A third sample, taken from the stock-piles at the furnace, and representing ore from many pits, shows, upon analysis—

	588.
	Per cent.
Metallic iron	45.50
Phosphorus	0.528
Phosphorus ratio	1.160

c

These ores are but poorly worked, the farmers of the neighborhood bringing it at will to the furnace and selling it by the ton. The management does not attempt to control the miners, either as to time of work or methods of mining. The banks of the Fitzburg and Cottage furnaces, which were opened in the same irregular manner, offered no opportunity for proper sampling, having been long abandoned.

The Hanging Rock region of Kentucky includes Carter, Boyd, and Greenup counties, and a portion of Lawrence.

The ores are carbonates and limonites, altered from carbonates, occurring in horizontal beds at well-defined d horizons.

The division of these ores adopted by Mr. P. N. Moore, in the *Geological Survey of Kentucky*, (Vol. 1, p. 69), is as follows:

(*a*) The limestone ores.

(*b*) The block ores.

(*c*) The kidney ores.

The limestone ores are so called because they rest upon limestones.

The block ores are so called from their peculiarity of cleaving into square-cornered blocks.

The kidney ores are named from the shape which they usually assume.

Many names are given by the miners to the different varieties under each of these groups, among which are e the following:

Big block, little block, big blue block, little blue block, big yellow kidney, little yellow kidney, black kidney, red kidney, lime kidney, roll kidney, upper limestone, lower limestone, slate ore, flag ore, china ore, gray lime.

The terms "big" and "little" block have reference to the thickness of the ore-bed, while the same terms applied to the kidney ores refer to the size of the individual kidneys, regardless of the thickness of the bed through which they may be scattered.

The terms yellow, black, and red are applied to the kidney ores according to the color of the ore, though reference is sometimes had, as in the case of the yellow kidney ores, to the color of the adhering clay.

Roll kidney is a peculiar rough ore, sometimes forming a continuous layer across a bed of kidney ore.

The limestone ores take their names from the horizons at which they occur, the upper ones lying above what f is known as the ferriferous limestone, the other occurring above the lower or sub-Carboniferous limestone, as above described.

Flag and slate ore are names given to certain local ores which occur in thin slabs or flags.

The term china ore is given to a coarse, sandy variety, of irregular occurrence, while the name of gray lime is applied to certain portions of the limestone ore, which is little altered and of a clear unspotted gray.

The limestone ores vary from unaltered carbonates or siderites to limonites.

The block ores show unaltered carbonate in the center of the blocks, surrounded by layers completely changed to limonite, while the kidney ores are cores of carbonate, inclosed by concentric layers of limonite, which at times constitute the entire kidney.

a The accompanying map of the Hanging Rock region, Fig. 93, shows the location of the various furnaces and the principal mining localities.

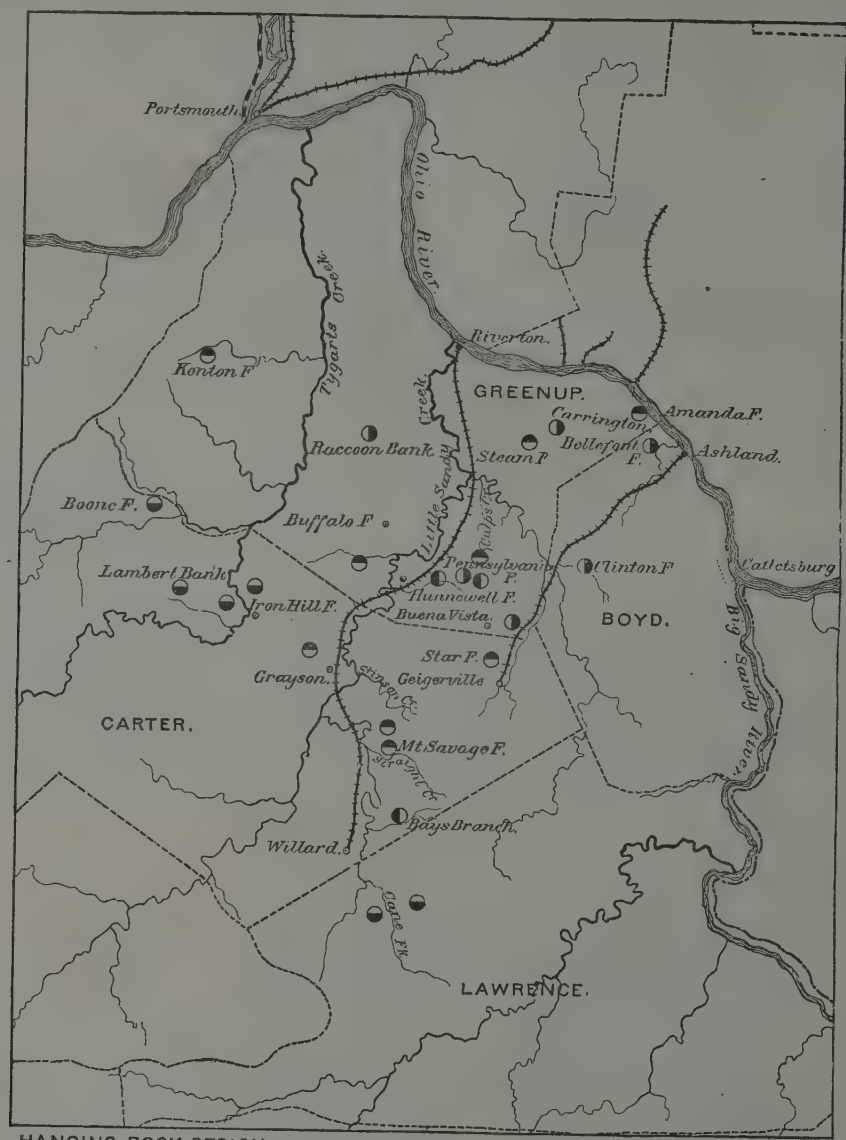


FIG. 93.

Samples were taken from none but working-pits, as all abandoned diggings were covered and fallen, and it was therefore impossible to secure average samples of the ore.

The ore in this region is almost invariably mined by stripping and benching, though in one or two instances short tunnels were run upon the bed.

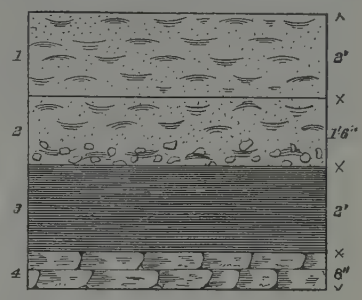
On *Reuben's branch* of East Fork, north of Pennsylvania furnace, in Greenup county, the little block ore has been quite largely worked.

The accompanying cut (Fig. 94) shows the ore-bed as opened west of the branch near the crown of the main ridge.

The ore was exposed by stripping, and was opened along 100 feet on the horizontal bed at this point. The kidney ore lying above the slate was not being worked, the quantity being very small. It is almost entirely altered to limonite, and the kidneys are much softened.

The block ore below the slate showed little unaltered carbonate. The blocks were often hollow or contained cavities filled with sandy clay, surrounded by a dense hard limonite. The analysis of two samples, the first of the kidney ore, the second of the block ore below the slate, yield results as follows:

	593.	594.
Metallic iron	54.39	32.02
Phosphorus	0.167	0 227
Phosphorus ratio	0.306	0.709



1. Yellow Clay.
2. White Clay with Kidney Ore.
3. Gray and Black Slate.
4. Block Ore.

FIG. 94.

The kidney ores are largely worked for Pennsylvania furnace.

Fig. 95 shows a section taken at the *Blancet mine*, on Pea Ridge, 1 mile south of the furnace.

The main ore-bed is that bearing the big yellow kidney, marked 7 in the cut. These kidneys, which occur irregularly scattered through the shale, vary in size from small grains to 6 inches in diameter. The cores are of dense unaltered carbonate, often crossed by fine veins of calcite. About this inner unaltered carbonate are concentric layers of limonite, which are, however, much folded and contorted, and are covered on the outermost surface with soft yellow ocher. This bed is divided at C by a rough layer of purplish ore, of irregular thickness, which is called "roll kidney". The bed of black kidney ore at 6, though only 2 inches in thickness, shows kidneys changed to limonite throughout. The bed is not thick enough to work alone, but the ore is separated in the process of benching for the yellow kidney which lies below it.

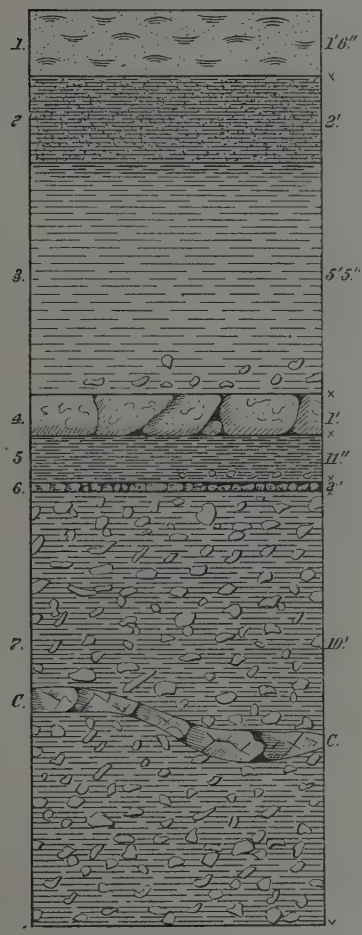
At 4 is a well-defined bed of coarse ore, with brown concentric rings, alternating with sandy layers. The outer coating is a dark-brown, sandy limonite, called china ore, and rejected at the furnace.

The ores from these four beds are compared in the following analyses:

	595.	596.	597.	598.
	Per ct.	Per ct.	Per ct.	Per ct.
Metallic iron	54.65	32.27	32.01	31.49
Phosphorus	0.698	0.423	0.513	0.139
Phosphorus ratio	1.278	1.311	1.603	0.441

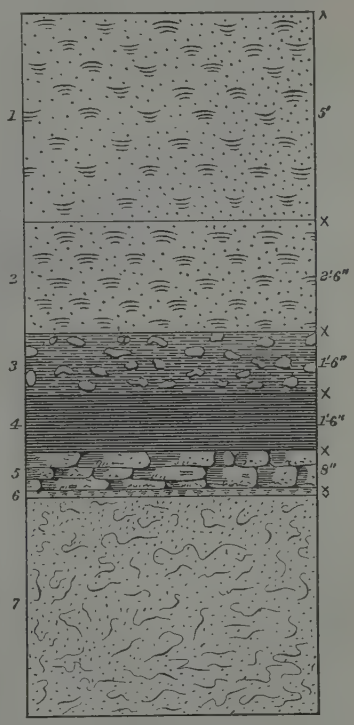
No. 595 is the black kidney ore from 6. No. 596 is yellow kidney ore at 7. No. 597 is the roll kidney ore at C. No. 598 is the china ore from 4.

It will be seen from the above that the black kidney ore, though it contains the highest per cent. of iron, has also the greatest amount of phosphorus of the four, while the china ore, rejected at the furnace, compares quite favorably with the kidney ores, its low phosphorus giving it even a greater value, though apparently the silica is much higher.



1. Clay.
2. Micaceous Shale.
3. Olive Shale.
4. China Ore.
5. Black Shale.
6. Black Kidney.
7. Olive Shale with Yellow Kidney Ore.

FIG. 95.



1. Yellow clay.
2. Fire clay.
3. Micaceous shale with kidneys.
4. Gray slate.
5. Block ore.
6. Clay.
7. Sandstone.

FIG. 96.

a Hunnewell furnace, on the line of the East Kentucky railroad, in Greenup county, is controlled, together with the Pennsylvania furnace above-mentioned, by the railroad company. It uses a variety of ores from many sources, some of them coming from beyond Willard, in Lawrence county. Figure 96 shows a section on *Turkey lick*, 1 mile east of the furnace. The kidneys occurring above the block ore are here but thinly scattered, though at time of large size. The block ore here shown is a dense ore, altered as usual to limonite on the surface, and showing ocher and fine veins of calcite when broken through the core. The analyses of this ore, together with an average sample from the stock-pile at Hunnewell furnace, are as follows:

b

	599.	801.
	Per cent.	*Per cent.*
Metallic iron	51.101	36.18
Phosphorus	0.173	0.341
Phosphorus ratio	0.339	0.943

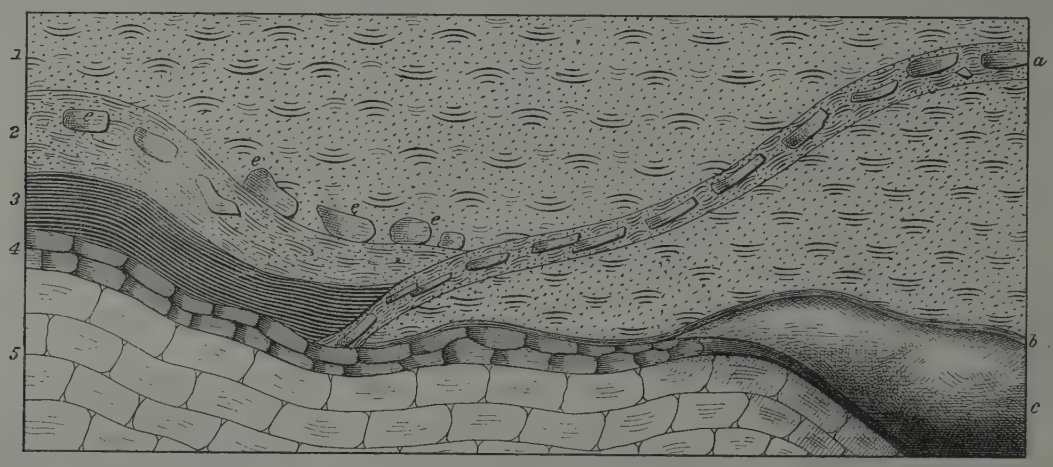
Sample 599 represents the block ore above described. Sample 801 is from the stock pile at the furnace.

Other ores in use at Hunnewell furnace will be mentioned under the description of the banks from which they come.

The Iron Hill furnace, on Tygart's creek, in Carter county, is run almost exclusively from the limestone ores.

c A section taken at the *Duzan* bank, 1½ mile northeast of the furnace, is shown in Fig. 97. The ore-bed, which conforms to the irregularities in the underlying limestone, is shown spreading over a bulge at *c;* the thickness of

d



e

1. Red clay, 2 ft.
2. Gray clay, 18 in.
3. Gray slate, 16 in.
4. Limestone ore, 8 in.
5. Lower limestone, 4 ft.

e.e.e. Sandstone in broken pieces.
a. Olive and red clay with line of sand boulders, 7 in.
b. Yellow clay above ore, 2 in.
c. Ore bed spreading over limestone bulge.

FIG. 97.

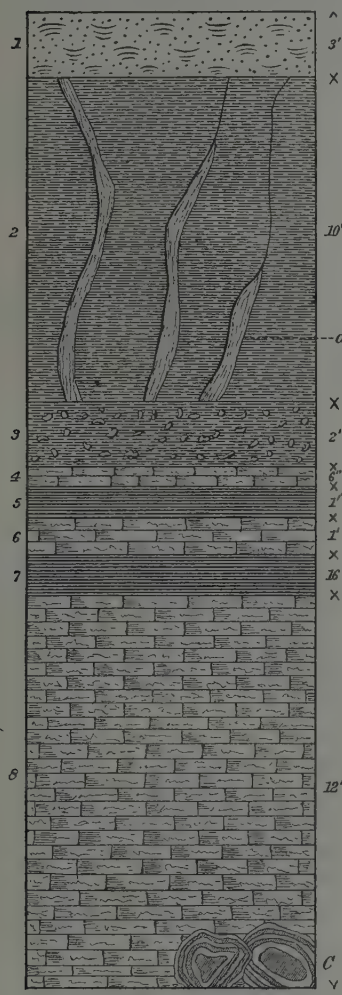
the bed, however, is still the same. The ore is soft, and much decomposed, and of a yellowish-gray color, coming from the bed in shaly flakes and thin plates, and is much contaminated by the clay-bed above it. The sample was taken along the whole surface of the bed exposed in the figure, marked 4, the bed being very wet at the time. The analysis shows—

f

	802.
	Per cent.
Metallic iron	37.32
Phosphorus	0.224
Phosphorus ratio	0.600

The *Lambert* bank, a section at which is shown in Fig. 98, is situated on the ridge between Clark's branch of Tygart's creek and Buffalo creek. This is an occurrence of ore peculiar to this locality, the deposit, according to Mr. P. N. Moore, lying 73 feet above the sub-Carboniferous limestone. The ore is an ochreous limestone ore, having a lean, earthy appearance, and a somewhat shaly texture. The great thickness of the bed here—over 14 feet, all

included—alone distinguishes this deposit from others of the region. Above the main ore-bed is a layer of micaceous a shale, thickly scattered with a peculiar fine kidney ore. These kidneys are quite small and round, consisting of a dark-brown limonite. At C is a distinct layer of what appears to be a silicious limestone, of a blue and often greenish color, decomposing to a soft, yellow powder upon exposure. The individual blocks are covered with concentric layers of sandy limonite. The formation is not persistent, and was here exposed only along 15 feet at the right and bottom of the accompanying section.



1. Clay.
2. Olive shale.
3. Kidney ore in shale.
4.6.8. Lime ore.
5.7. Slate and mired clay.
C. Rough limonite.
a. Clay seams.

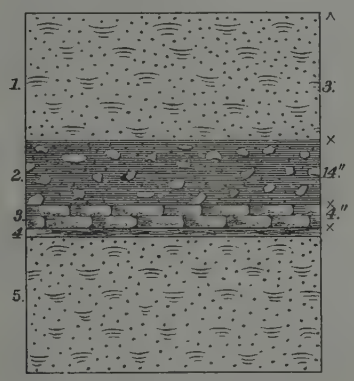
FIG. 98.

The following are the three analyses of samples taken from the Lambert bank: b

	803.	804.	805.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	35.36	34.82	40.48
Phosphorus	0.260	2.479	0.737
Phosphorus ratio	0.735	7.119	1.821

No. 803, from kidney ore at 3; No. 804, from the main bed 8, including the portions (4 and 7) above the slate-seams; No. 805 is the ore from the bed at C, taken from all portions of the exposed lumps.

c



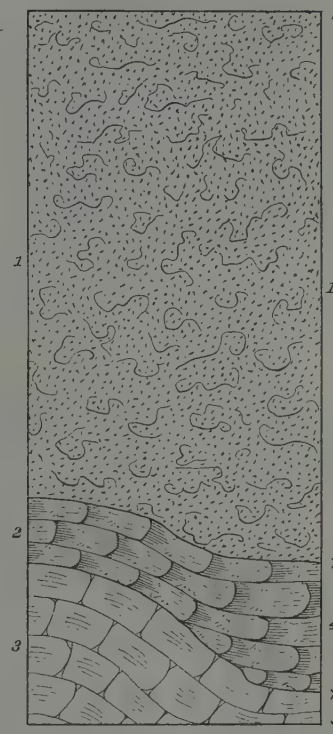
d

1. Yellow Clay.
2. Kidney ore in micaceous sand stone.
3. Little block ore.
4. White and gray clay.
5. Yellow clay.

e

FIG. 100.

These results show the kidney ore at 3 to be the only available ore at this bank. The very high per cent. of phosphorus in the other beds, regardless of the low per cent. of iron present, renders them utterly unfit for the manufacture of good pig-metal, and recourse must be had to other ores.



1. Sandstone.
2. Limestone ore.
3. Lower limestone.

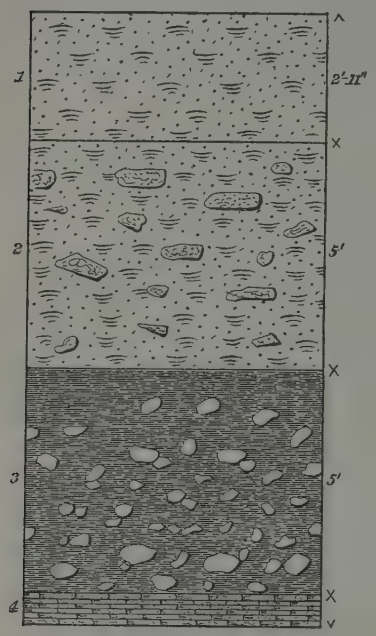
FIG. 99.

Fig. 99 shows a section at the *Furgerson* bank, an opening upon the lower limestone ore, 2½ miles northwest of Iron Hill furnace. Here the sandstone overlying the ore-bed is well defined and unusually thick. The figure shows the face of ore from which the sample was taken, illustrating a bulge in the underlying limestone. The ore is here f exposed by a small cut on the outcropping bed, from which none had been taken. The sample here taken shows upon analysis the following result:

	806.
	Per cent.
Metallic iron	34.55
Phosphorus	2.51
Phosphorus ratio	7.265

a The bed was here very little altered, and consisted of a dense blue carbonate, changed slightly to limonite on the most exposed edges. The high phosphorus will render the ore useless at this particular point.

The difference between the soft decomposed ore, shown in Fig. 97, above which the thick sandstone is wanting, and the unchanged ore under the sandstone, shown in Fig. 99, is very striking, and whether due to the weathering or not must be determined by other samples offering similar comparisons.



1. Red clay.
2. Gray clay, with sandy boulders and sand kidneys.
3. Shale, with kidneys of lime ore, "Lime Kidneys."
4. Slate ore.

FIG. 101.

The ores of *Robin's run*, a branch of Sandy creek, in Carter county, are largely mined for Mount Savage furnace. Fig. 100 shows a section taken above No. 3 coal at the Stewart bank. The opening is a small one, on the side of the ridge, half a mile north of Mr. Stewart's house. Two samples were taken from this opening, which upon analysis gave results **b** as follows:

	807.	808.
	Per cent.	*Per cent.*
Metallic iron	31.20	35.63
Phosphorus	0.187	0.170
Phosphorus ratio	0.599	0.477

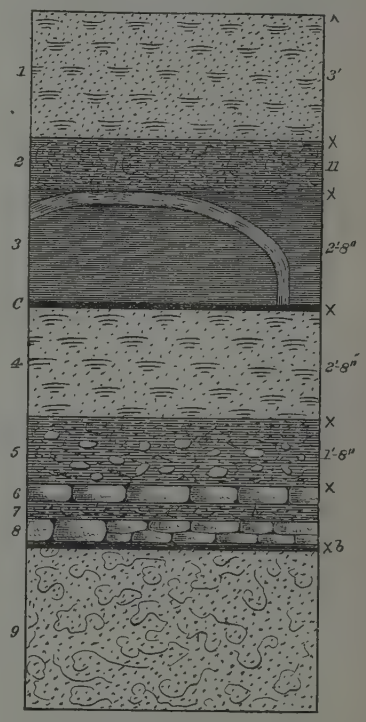
No. 807 is kidney ore, from the seam at 2; No. 808 is the block ore **c** from 3. Above this ore, near the crown of the hill, an old entry exposes No. 4 coal. Continuing eastward on the north side of Robin's run, the ridges, which rise some hundred feet above the stream-bed, are lined and terraced to the crowns with the trenches and their accompanying dump-piles, left where the ore has **d** been stripped along the outcrops of the beds.

These old diggings afford no opportunity for sampling. On the south side of Robin's run, 2 miles directly north of Mount Savage furnace, the ore is worked at several horizons on the side of a steep hill, rising about 200 feet. The section, at the upper opening, is shown in Fig. 101. The ore here was worked in two main benches, the bed marked 4 in the figure not being exposed when visited.

The amount of stripping and the hardness of the slate at this point renders the extraction of the kidney ore most difficult.

e This ore is known as the gray-lime kidney, and lies above No. 5 coal, wanting. The kidneys are dense cores of sandy carbonate, surrounded by very thin layers of limonite, and the ore has a lean, sandy appearance throughout, giving, upon analysis, the following result:

	811.
	Per cent.
Metallic iron	27.73
Phosphorus	0.927
Phosphorus ratio	3.343



1. Surface clay.
2. Micaceous sandstone.
3. Gray shale.
4. Gray clay. *C. Coal seam, 4/12".*
5. Micaceous sandstone. *b. Fire clay, 4/12".*
6. Little block ore
7. Micaceous sandstone.
8. Little block ore.
9. Sandstone over No. 3 coal.

FIG. 102.

f The horizon of the little block ore is here 100 feet below the above-described bed, and is exposed by a small opening upon the same hillside.

Fig. 102 shows this opening in section. The little block ore is here separated from the underlying bed, known as the little blue block, by a layer of micaceous sandstone. The ores from these two beds is not separated in mining and differ little in appearance.

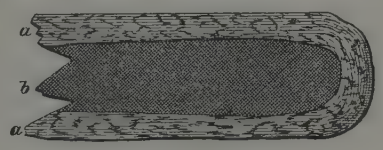
A sample was taken from each of these beds, and the ores are compared in the following analyses:

	809.	810.
	Per cent.	*Per cent.*
Metallic iron	37.32	34.77
Phosphorus	0.215	0.279
Phosphorus ratio	0.576	0.774

No. 809, little block ore from 6. No. 810, little blue block from 8.

Much care is exercised at Mount Savage furnace in the selection and sorting of the ores, and the result is fairly illustrated in the above analyses.

Fig. 103 shows a section through one of the ore-blocks from the bed at 8. The center (*b*) is unaltered carbonate



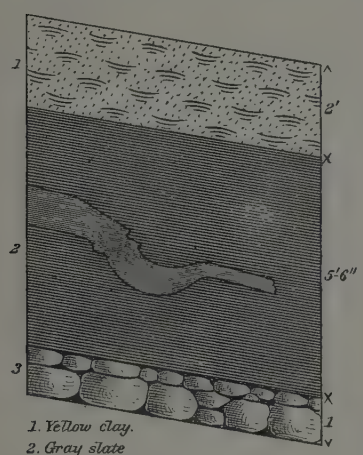
a–a. Limonite.
b. Unaltered carbonate.
FIG. 103.

ore, of a grayish blue tint, while the outer layers are changed to a light-brown limonite (*a*).

Besides these, the yellow kidney ores have been worked for Mount Savage furnace, and were found mixed with other ores upon the stock-pile, from which an average sample was taken, showing upon analysis:

	812.
	Per cent.
Metallic iron	41.30
Phosphorus	0.223
Phosphorus ratio	0.540

Fig. 104 shows a section on *Bays branch*, 3¼ miles south of Mount Savage furnace. A tunnel has here been run some 30 feet upon the bed of red kidney ore, which here dips 10° northeast.

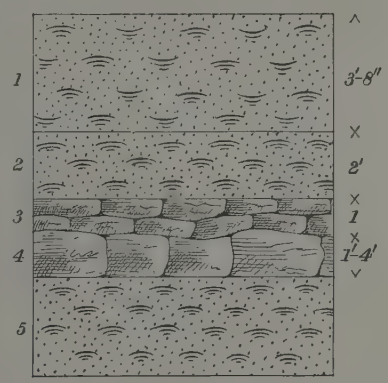


1. Yellow clay.
2. Gray slate
3. Red kidney ore.
FIG. 104.

In its general appearance the ore resembles the block ores, but comes from the bed in more rounded masses, though hardly in distinct kidney forms. It is a carbonate changed to a reddish limonite on the surfaces of the blocks. The ore was being worked for Hunnewell furnace, and lies 36 feet below the horizon of the yellow kidney ore, which was formerly worked on the hillside immediately above it.

The red kidney ore gives, upon analysis:

	813.
	Per cent.
Metallic iron	22.81
Phosphorus	0.079
Phosphorus ratio	0.346



1. Red clay.
2. Gray clay.
3. Lime ore (altered).
4. Lime ore (unaltered).
5. Gray clay.
FIG. 105.

South of Willard, on Dry fork, preparations were being made for extensive mining.

The limestone ores were sampled at *Shepherd's* bank, on Cane fork, in Lawrence county, where the accompanying section (Fig. 105) was taken. The ore in this instance rests upon a bed of gray clay. The upper one-foot of the bed is decomposed and partly altered to limonite, and this part is called red lime ore, to distinguished it from the unchanged gray lime ore which forms the lower portion of the bed.

The ore is shipped to Hunnewell furnace, and is taken from many other pits in the immediate neighborhood. The upper and the lower portions of the bed show a marked difference in the following analyses:

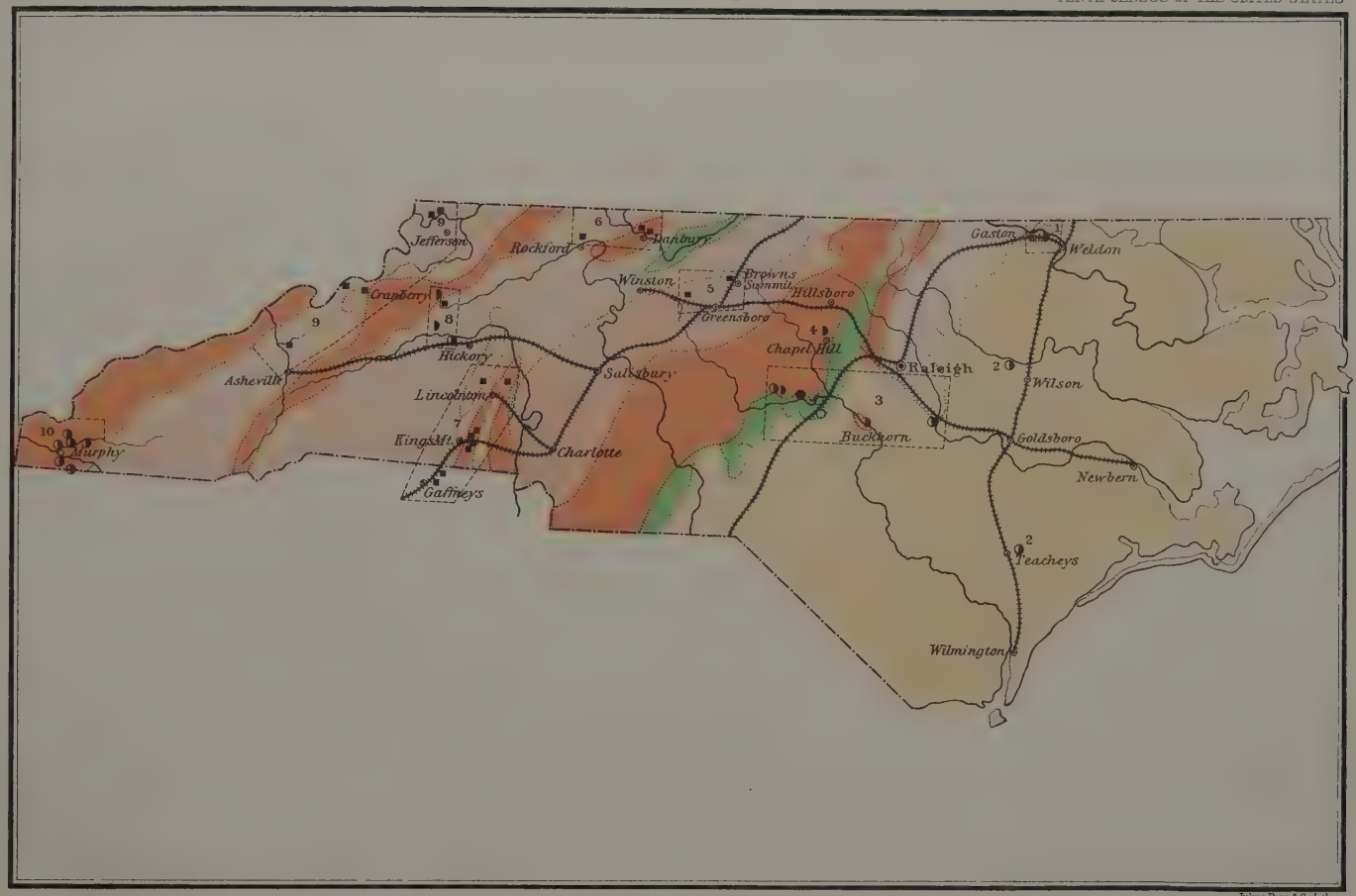
	814.	815.
	Per cent.	*Per cent.*
Metallic iron	40.61	32.46
Phosphorus	0.126	0.141
Phosphorus ratio	0.313	0.434

No. 814 is the limonite from 3. No. 815 is the gray lime from 4.

a Sample 814, which seems to be a particularly rich variety of limestone ore, gives, upon full analysis, results as follows:

	814.		814.
	Per cent.		*Per cent.*
Sulphur	0.227	Carbonic acid	3.66
Phosphorus	0.126	Sulphuric acid	0.02
Iron, metallic	40.61	Phosphoric acid	0.290
		Carbon in carbonaceous matter	0.15
Silica	14.37	Hygroscopic water	1.49
Iron, protoxide	4.93	Water of composition	8.54
Iron, peroxide	53.93	Total	100.112
Alumina	9.36		
Manganese, protoxide	1.26	Per cent. of insoluble silicious matter	19.43
Lime	1.03		
Magnesia	0.52	Silica	14.37
Iron, disulphide	0.072	Alumina	4.98
Nickel, sulphide	0.25	Magnesia	0.07
Cobalt, sulphide	0.21		
Copper, sulphide	0.03	Total	19.42

b



Julius Bien & Co Lith.

IRON ORE SAMPLE MAP OF NORTH CAROLINA.

Geology from Geological Map of North Carolina by W. C. Kerr. 1875.

Tertiary — Triassic — Huronian. — Upper Laurentian. — Lower Laurentian.

■ Magnetite. ◗ Specular. ○ Hematite. ◑ Limonite. ● Black Band. [1] Group 1.

Scale: 60 miles-1 inch.

0 10 20 30 40 50 60 100

NOTES ON SAMPLES OF IRON ORE COLLECTED IN NORTH CAROLINA.

By Bailey Willis.

The iron ores of North Carolina may be divided geographically into ten groups, as follows:

1. Specular and magnetic ores near Gaston, Halifax county. Age: Huronian.
2. Bog-ores of the eastern counties. Age: Tertiary; recent.
3. Specular, hematite, limonite, and blackband ores of Chatham, Moore, Harnett, and Johnston counties. Age: Huronian and Triassic.
4. Chapel Hill mine, Orange county. Age: Huronian?.
5. Titaniferous magnetic ore of Guilford and Rockingham counties. Age: Lower Laurentian.
6. Magnetic ores of Stokes and Surrey counties. Age: Huronian.
7. Magnetic and limonite ores of Lincoln and Gaston counties and York county, South Carolina. Age: Huronian and Lower Laurentian.
8. Limonite of Burke and magnetic and specular ore of Caldwell county. Age: Huronian and Upper Laurentian?.
9. Magnetic ores of Ashe, Mitchell, and Madison counties. Age: Upper Laurentian.
10. Limonites of Cherokee county. Age: Huronian.

In the above division the term "age" refers to the age of the rocks in which the ores occur according to W. C. Kerr's determination, not to the period of formation of the ores, which does not enter into an economic description.

1. *Ores near Gaston, Halifax county.*

On page 220 of Professor Kerr's report for 1875 is given the following sketch of the ore-beds near Gaston:

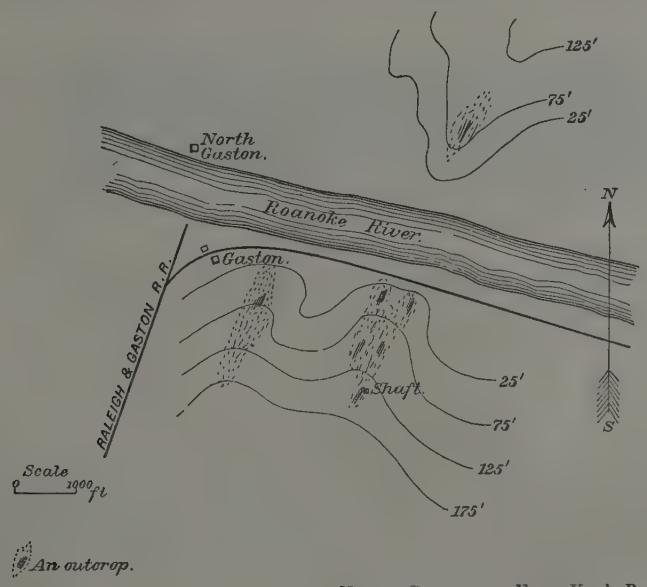


Fig. 106.—Sketch map of the vicinity of Gaston, North Carolina. From *Kerr's Report*, 1875, p. 220.

About 1 mile east of Gaston and one-half mile south of the river several prospecting trenches had been opened on the more easterly of the veins, and an ore-body 18 inches to 2 feet thick at the surface had been uncovered in one. A shaft had been sunk 25 feet upon this vertical vein, and it was stated that it widened as it went deeper.

a The strike of this vein is nearly due north, and it is said to show itself 8 feet thick in the bed of the Roanoke at low water; it was also said to outcrop north of the river, but a diligent search failed to reveal it. Sample 151 represents the micaceous specular ore seen in the shaft referred to.

Five miles south of Gaston, on the hills north of the Roanoke, and also 7 miles up the river above Gaston, surface pieces of a strongly magnetic trap-rock were seen; but the magnetic ore, described by Professor Kerr, was not found.

b

	151.
	Per cent.
Iron	49.83
Phosphorus	0.005
Phosphorus in 100 parts iron	0.010

2. *Bog-ores of the eastern counties.*

The alluvial beds of the eastern portion of the state contain numerous deposits of bog-ore. These lie in the form of irregular horizontal sheets and scattered nodules a little below the level surface, and are discovered by the loose pieces lying on the ground in the turpentine pine forests, or turned up by the farmer in plowing.

A bed of this ore, on the farm of D. T. Boney, 3 miles east of Teachey's, in Duplin county, covers a curved c belt about 1 mile long and one-quarter mile wide. It has been found in ditching and plowing, and is often but a few inches below the surface. The sheets are very irregular in form, and their thickness is unknown, as no attempt has been made to work the ore, which is represented by sample 153. Hand-specimens obtained here contain pieces of wood altered to limonite.

	153.
	Per cent.
Iron	46.70
Phosphorus	1.085
Phosphorus in 100 parts iron	2.323

d In Nash county, near Toisnot swamp, is a similar bed of ore, known as the *Bloomary* iron mine. This was worked in 1812, and again during the late war. This bed is 200 yards long, 75 yards wide, and averages about 3 feet in thickness, but thins out toward the edges. Beneath it is white sand, and above it 2 to 4 feet of brown earthy soil, containing nodules of the same ore. Portions of this ore are very sandy, but sample 154 is a fair average of the greater part of the ore seen.

e

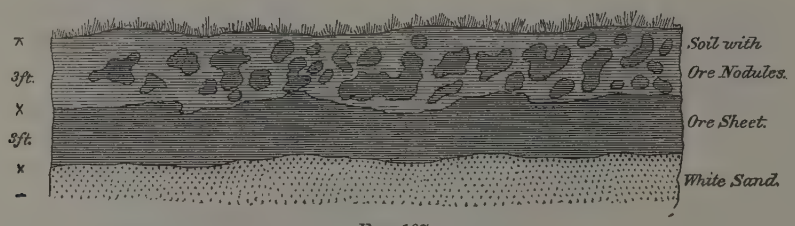


FIG. 107.

This ore is 7 miles in a direct line from the railroad, and is 8 miles northwest of Wilson.

f

	154.
	Per cent.
Iron	49.90
Phosphorus	0.049
Phosphorus in 100 parts iron	0.098

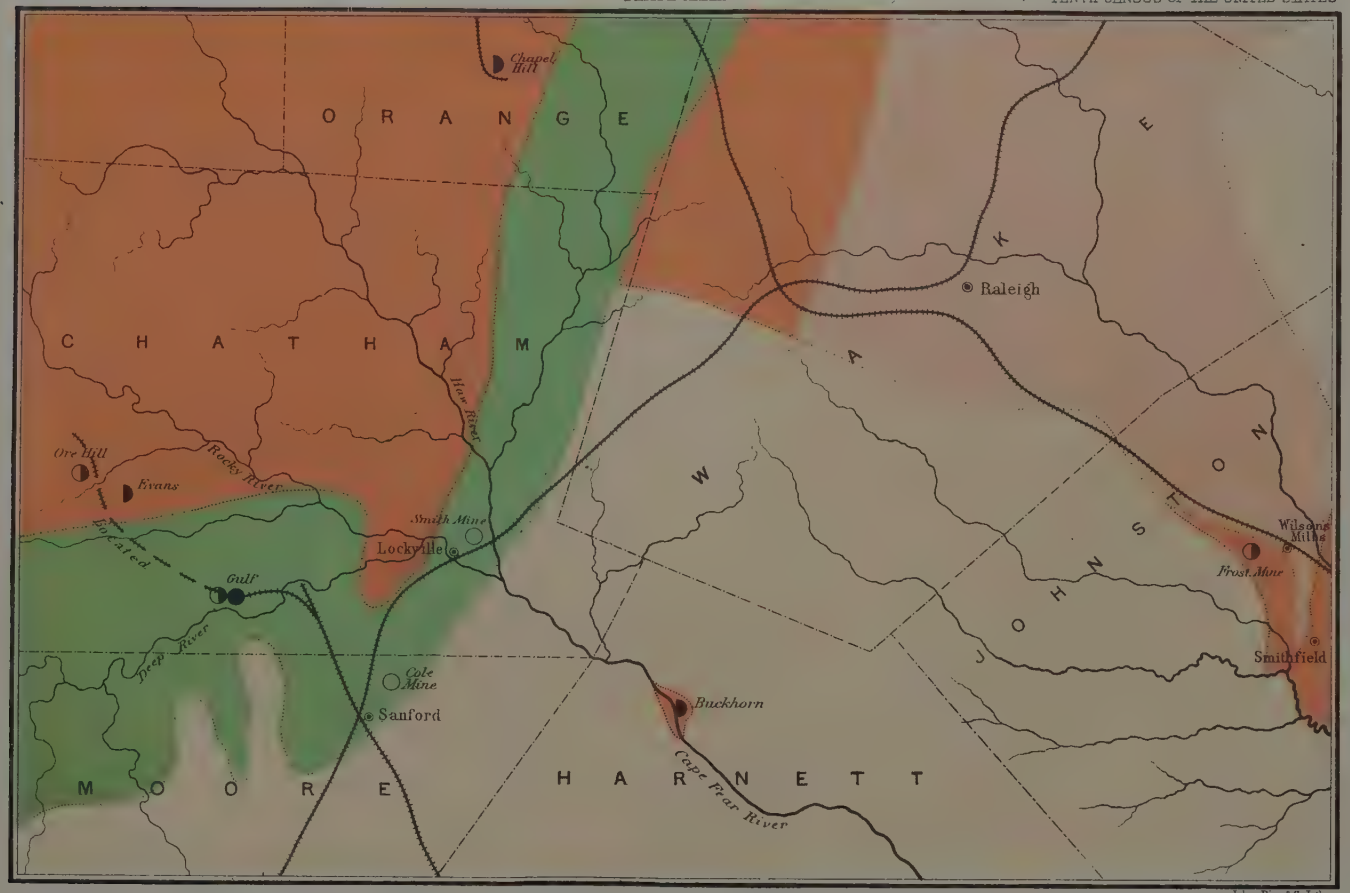
3. *Specular, hematite, limonite, and black-band ores of Chatham, Moore, Harnett, and Johnston counties.*

The ores included in this group differ widely in character, and there is but little geological connection between the deposits. These are:

Huronian: Limonites and specular ores; and

Triassic: Hematite, blackband, and limonite.

(*a.*) *Huronian limonites.*—Wilson's Mills is a small station on the North Carolina railroad, 22 miles south of Raleigh. The country is undulating, with swamps between the low hills. Two miles west of the station, near



Julius Bien & Co. Lith.

IRON ORE MINES OF GROUPS THREE AND FOUR (NORTH CAROLINA).

Tertiary. Triassic. Huronian. Upper Laurentian. Specular. Hematite. Limonite. Black Band.

Copied from Post Route Map and Kerr's Geological Map for 1875.

Scale: 8 miles-1 inch.

0 1 2 3 4 8 16

Isaac Parish's, a small stream, named Poplar branch, flows through a thickly wooded swamp, around the northeast, a south, and southwest sides of a ridge 50 feet high. The surface of this ridge, for the space of a quarter of a mile northwest and southeast, is covered with loose pieces of limonite, and near the eastern edge of the ridge is an old pit, 10 to 15 feet deep and 70 feet long, in which is exposed a vertical face of ore 6 feet high and 20 feet long. Outcrops of gneiss occur on the hill northwest of this ridge. Across the swamp one quarter mile northeast of the pit, surface fragments of ore are widely scattered over a gentle slope. A similar ore also occurs 1½ mile southwest of the pit on lands of Messrs. Turner and Avery. Ore was dug in the old pit described and at Mr. Avery's in 1812.

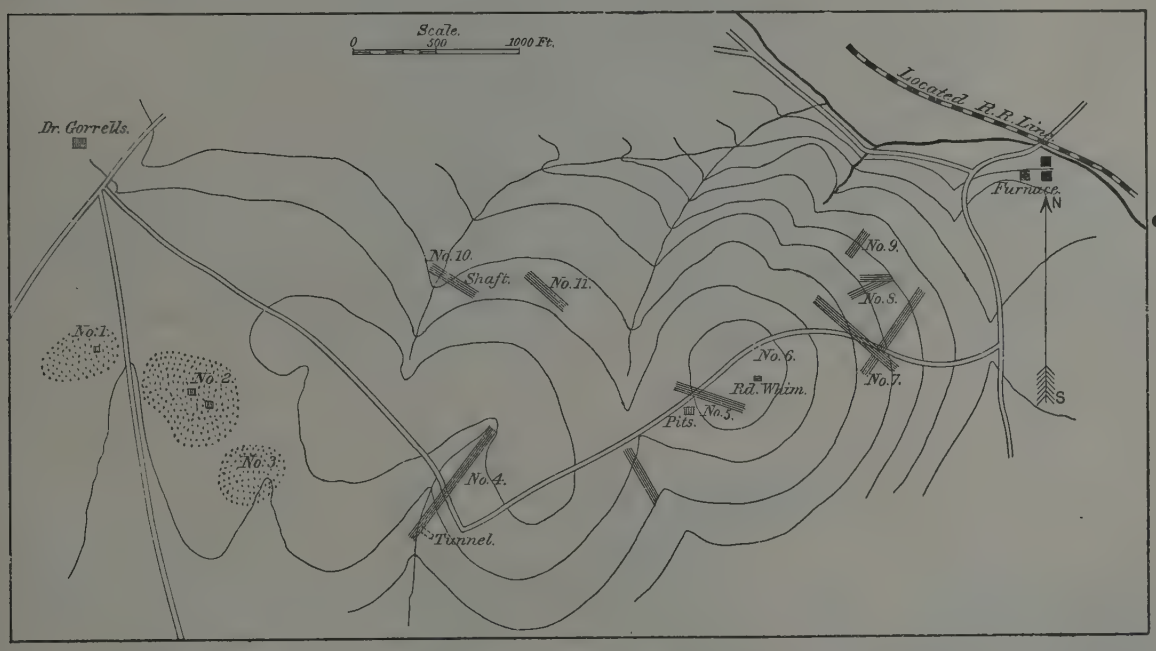
Sample 152 was taken as an average of the face of ore exposed in the pit:

	152.
	Per cent.
Iron	47.99
Phosphorus	0.900
Phosphorus in 100 parts iron	1.875

b

Ore Hill is a noted locality in Chatham county. It lies upon the projected line of railroad running northwest from Fayetteville, and the road was already completed to within 12 miles of it and graded beyond it in February, 1880. There are a number of deposits of limonite and one of hematite, which have all been opened more or less for the furnace which ran here during the late war.

The accompanying map, copied from Professor Kerr's report for 1875, gives a good idea of the position of the different deposits of ore. Numbers 4, 10, and 11 were best exposed. They are represented respectively by samples 160, 159, and 158. c



d

e

FIG. 108.—MAP OF ORE HILL, CHATHAM COUNTY, NORTH CAROLINA. From *Kerr's Report*, 1875.

The vein marked No. 4 on the sketch consists of hematite, accompanied by white quartz. The outcrop is not less than 1,000 feet in length in a northeast and southwest direction, and varies from 15 to 20 feet in width. Near the southern end a tunnel has been driven in from the surface across the vein; but that portion of it which had f not caved in was filled with water to the roof and could not be examined. Sample 160 was selected from the face of ore exposed above the old tunnel where it had caved in, masses of quartz which could be removed by handpicking not being included.

At No. 10 a large shaft has been sunk, it is said, to a depth of 90 feet in the ore; the sides have caved in, and it is now not over 40 feet deep. The ore is well exposed in the sides of the shaft and in the bottom and sides of a pit 20 feet wide which runs off from it. It is a very porous limonite, of apparently uniform character, and free from mechanical mixtures of rock. The width of the vein is something over 20 feet, but could not be definitely ascertained.

The vein marked No. 11 had been worked in an open cut and was much obscured by the caving in of the overlying soil. Its width appeared to be 10 or 15 feet, and the ore was similar to No. 10.

a Of the other veins nothing was to be seen but small irregular outcrops, from which no safe estimate of their size and character could be made. Test-pits have apparently been opened on them all, but they are now caved in.

Analyses.

b

	158.	159.	160.
	Per cent.	*Per cent.*	*Per cent.*
Iron	57.23	41.71	44.99
Phosphorus	0.390	0.232	0.248
Sulphur	0.263	.....	.....
Phosphorus in 100 parts iron	0.681	0.556	0.551

The following is the complete analysis of 158:

c

	158.		158.
	Per cent.		*Per cent.*
Silica	1.28	Titanic acid	1.04
Iron, protoxide	0.23	Carbon in carbonaceous matter	0.17
Iron, peroxide	81.19	Hygroscopic water	2.57
Alumina	2.38	Water of composition	9.32
Lime	0.14	Total	100.066
Magnesia	0.01		
Iron, disulphide	0.473	Per cent. of insoluble silicious matter	1.82
Nikel, sulphide	0.02		
Copper, sulphide	0.02	Silica	1.28
Potassa	0.14	Alumina	0.48
Soda	0.01	Lime	0.06
Carbonic acid	0.18	Magnesia	0.01
Phosphoric acid	0.893	Total	1.83

(*b.*) *Huronian specular ores.*—A vein of compact blue specular ore has been discovered on the land of Mr. Evans, d 7 miles northwest of the Gulf, and about 1 mile from the located line of railroad already referred to. There is a low ridge, which runs east and west, and the presence on it of surface pieces of ore led to the opening of the prospecting pits in which the vein is exposed. The accompanying rock is a decomposed talcose-schist, which dips with the vein about 45° north, 30° west. The thickness of the vein was stated at 7 feet; the *débris* in the bottom of the half-filled tunnel permitted only 4 feet to be seen. The greatest depth reached on the vein was 20 feet. Sample 157 was taken as an average of about 5 tons of ore lying by the side of the pits:

e

	157.
	Per cent.
Iron	25.75
Phosphorus	0.018
Phosphorus in 100 parts iron	0.070

f

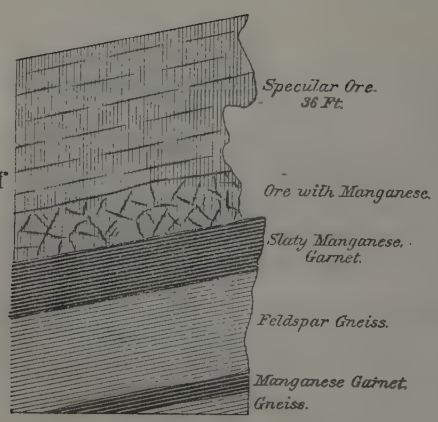


FIG. 109.

The *Buckhorn* iron mine is said to have presented before being worked a vertical face of specular ore 36 feet in height, crowning a hill whose summit is 175 feet above the Cape Fear river. When visited, in February, 1880, there remained but a few loose blocks of poor ore in a pit 80 feet long by 40 feet wide by about 15 feet deep. This pit was an approximate mold of the mass of ore, which had the same horizontal dimensions and a maximum thickness of perhaps 50 feet.

Search was made for ore in several places south and northeast; a hundred yards from the pit in the latter direction a small vein of poor ore, similar to that left in the mine, was found. Similar ore caps a hill on the right bank of the river, immediately opposite Buckhorn and half a mile from it.

All the good ore at the mine was removed and used in the Buckhorn furnace, built under the supposition that the ore-deposit was very large.

The annexed section (Fig. 109) of the original deposit is given by Professor Kerr on page 222 of his report for 1875:

This section has been completely obscured or removed by the mining operations, and there now remain only the very much decomposed gneiss and slate that form the sides of the pit.

	No. 155.
	Per cent.
Metallic iron	57.31
Phosphorus	0.016
Phosphorus in 100 parts iron	0.043

(*c.*) *Triassic hematite.*—An interesting form of hematite occurs in the slightly inclined stratified beds of the Trias, in the eastern part of Chatham and Moore counties. The ore consists of rounded concretions, varying in size from small grains up to half an inch in diameter, cemented by a red ocher. It lies in thin beds, conformable to the bedding of the associated clays, and covers a considerable area, the outcrops extending from Lockville to a point 9 miles southwest near Sandford.

In the following sketch and section the principal openings of the *Smith* mine, 1 mile east of Lockville, are represented. The ore was first opened in the pit marked A on the west of the branch. It gave out about 10 feet

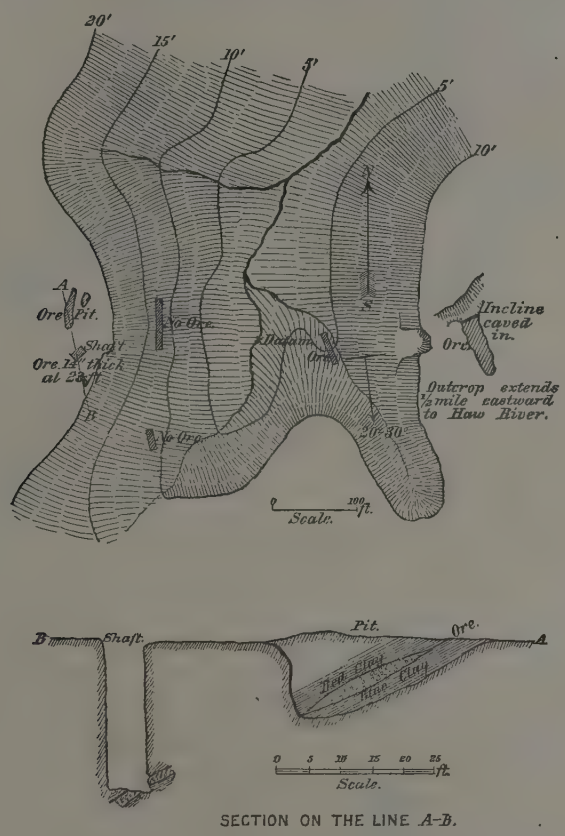


FIG. 110.—SKETCH OF THE SMITH MINE, NORTH CAROLINA.

from the surface, but was found again at a depth of 25 feet in the shaft. (See section A—B.) On the east of the branch the ore was followed in the incline about 15 feet; it then gave out and was not found again, possibly because the incline was driven over it.

Sample 164 is from the ore in the shaft and pit, west of the branch, where the maximum thickness of the bed is 14 inches.

	No. 164.
	Per cent.
Iron	43.02
Phosphorus	0.593
Phosphorus in 100 parts iron	1.380

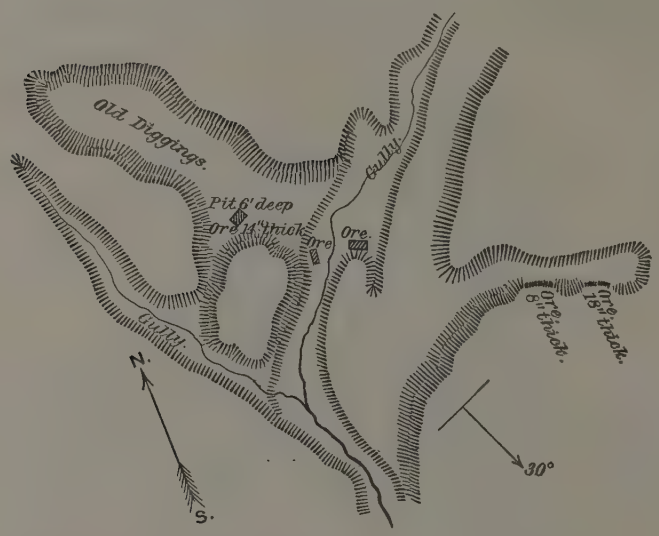
a A very similar bed of ore occurs 2 miles northeast of Sandford and 9 miles southwest of Lockville. This is known as the *Cole* mine, and the ore was formerly marked in a blomary, but it became too hard to be dug with a pick and was abandoned. Like that at the Smith mine, this ore dips between 20° and 30° south by east, and varies in thickness from 8 to 18 inches.

The ore is represented by sample 163.

b

	No. 163.
	Per cent.
Iron	48.67
Phosphorus	0.313
Phosphorus in 100 parts iron	0.643

c



d

FIG. 111.—SKETCH OF THE COLE MINE, NORTH CAROLINA.

(*d*) *Blackband and ball-ore of the Trias.*—The following section (Fig. 112) (*a*) of the Deep River coal-beds, taken in an old shaft at the Gulf, shows the relation of these two ores to the two coal-seams.

The ball-ore occurs in rounded masses, from 4 to 8 inches in diameter, of a drab color, in a dark brown shale. It e is represented by sample 156.

The blackband is compact and homogeneous. Sample 161 was taken from the bed exposed in the incline of J. L. Horton's coal mine at the Gulf, about 30 feet from the outcrop.

(*e*) *The Triassic limonites* are probably the weathered outcrops of the blackband or ball-ore, which accompany the coal. Half a mile west of the Gulf a small shaft had been sunk and such a bed of limonite exposed. The ore lay in rounded masses in a yellowish clay. It is represented by sample 162:

f

	Ball-ore.	Blackband.	Limonite.
	156.	161.	162.
	Per cent.	*Per cent.*	*Per cent.*
Iron	34.96	21.25	20.33
Phosphorus	0.312	0.017	0.068
Phosphorus in 100 parts iron	0.892	0.080	0.334

4. *Chapel Hill Mine.*

In the southern portion of Orange county are rounded hills, 50 to 100 feet in height, the result of erosion of the decomposed Huronian rocks. Chapel hill, one of the principal of these, lies 9 miles south of University station, on the railroad between Raleigh and Greensborough. Upon its summit a true fissure-vein filled with iron-bearing quartz may be traced in a north and south course for about 1,000 feet; beyond the hill it is said to separate into a

a See page 329.

number of smaller fissures. The main vein is crossed near the southern end by another smaller vein, with a course of about north 60° east; both are well exposed by outcrops and test-pits (see accompanying sketch, Fig. 113). At the main shaft the vein has a total thickness of 10 feet. The ore at the sides is very lean, but toward the center the proportion of iron increases rapidly, and it is possible that 6 feet out of the 10 can be worked profitably; sample 402 was taken as an average of this central portion of the vein. Toward the summit of the hill the vein widens to 12 feet.

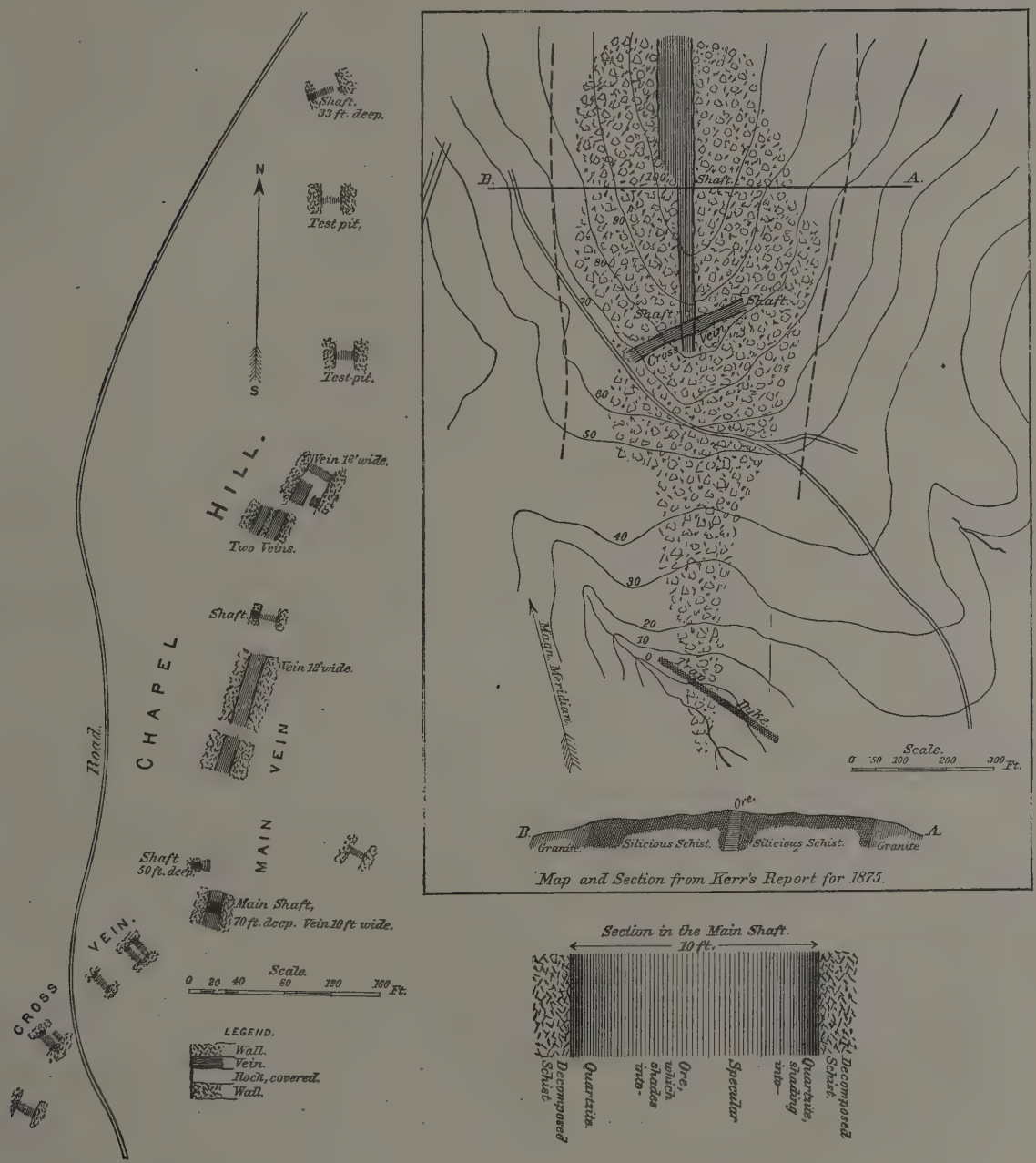


FIG. 113.—MAP AND SECTIONS OF THE CHAPEL HILL MINE, NORTH CAROLINA.

Just beyond it is faulted and separated by a horse, similar to the wall rock; 40 feet farther north there is but one vein, 18 feet wide. The quartz here carries but a very small percentage of ore. The northern end of the vein does not appear to exceed 12 feet in width. At the last opening a shaft has been sunk on the west of the vein, and some of the ore has been thrown out by a blast; sample 403 was taken as an average of this ore, which is slightly magnetic.

Analysis.

a

	No. 402.	No. 403.
	Per cent.	*Per cent.*
Phosphorus	0.057	0.170
Iron	37.91	42.64
Sulphur	0.153	.....
Phosphorus in 100 parts iron	0.150	0.399

When this mine was visited in 1880, the grading of a railroad was progressing rapidly between it and University station, on the main line between Raleigh and Greensborough. Following is the complete analysis of No. 402:

b

	402.		402.
	Per cent.		*Per cent.*
Silica	43.00	Hygroscopic water	0.09
Iron, protoxide	1.45	Carbon in carbonaceous matter	0.01
Iron, peroxide	52.34	Water of composition	0.55
Alumina	2.07	Total	100.098
Manganese, protoxide	Trace.		
Lime	0.10	Per cent. of insoluble silicious matter	44.49
Magnesia	0.02		
Iron, disulphide	0.287	Silica	43.00
Copper, sulphide	Trace.	Alumina	1.40
Carbonic acid	0.05	Lime	0.07
Phosphoric acid	0.131	Magnesia	0.02
Titanic acid	Trace.	Total	44.49

c

5. *Titaniferous magnetic ore of Guilford and Rockingham counties.*

A range of titaniferous magnetic ore extends from Forsythe county, in a northeast direction, across Guilford and into Rockingham, a distance of about 30 miles. The right to mine on this range is leased and owned by the North Carolina Central Iron Company, which has explored the entire length of the range, and begun mining at two points—the first, a mile north of Friendship, in Guilford county; the second, 5 miles northwest of Brown's summit, in Rockingham. The former is known as the *Tuscarora Iron-Works*. Forges were erected here and considerable d iron made, but the works have been idle for several years. The iron range lies about a quarter of a mile south of the works and has been traced, with but little interruption, for nearly a mile in a straight line, a little north of east (see sketch, Fig. 114).

The greatest depth was reached in the Sargent shaft, which was sunk 109 feet. A tunnel, run south from the bottom, is said to have struck a vein of ore 12 feet thick. The dip on the surface is about 70° a little east of south, but it is said to change to the northwest in the tunnel. About 10 tons of ore had been left near the pits around the shaft; sample 167 was selected from these piles. (For its analysis, see page 560 *b*.)

Twenty miles northeast of *Tuscarora* is the other mine, worked by the company, which is now in operation. It is known as the *Dannemora*.

The following sketches (Figs. 115 and 116) show the line of outcrop, the works on the surface, and the plan and e sections in the mine. The first work was done in the incline No. 1. According to the statement of the superintendent the ore gave out 10 feet from the surface, but was found again 20 feet farther down; it widened to 12 feet, which is the thickness 90 feet from the surface in the incline, 70 feet vertically. At this depth a drift has been driven along the vein and stoping has been begun. A small winze has been sunk 20 feet farther on the incline, and the ore is said to narrow to 1 foot in thickness. Before the horizontal drift reached the second incline the ore was pinched out by the granite walls.

As the ore-body thus opened gives out just beyond incline No. 1, its dimensions are pretty well ascertained. It is approximately 125 feet long, 80 feet in incline width, and 12 feet thick. The drift had been extended to another lens of the same thickness, northeast of it, and the surface outcrops and trenches indicate the existence of others to the southwest. This ore is accompanied by chlorite and mica, which are sufficiently decomposed, even at the f depth of the tunnel, to be readily dug with a pick. The ore is separated on the surface, by screening, into lump and fine ore, the former being shipped for fettling, the latter for blast-furnace use. These are represented in the following analyses:

	LUMP.	FINE.
	165.	166.
	Per cent.	*Per cent.*
Phosphorus	0.023	0.001
Iron	48.31	46.89
Sulphur	0.089	.....
Phosphorus in 100 parts iron	0.048	0.002

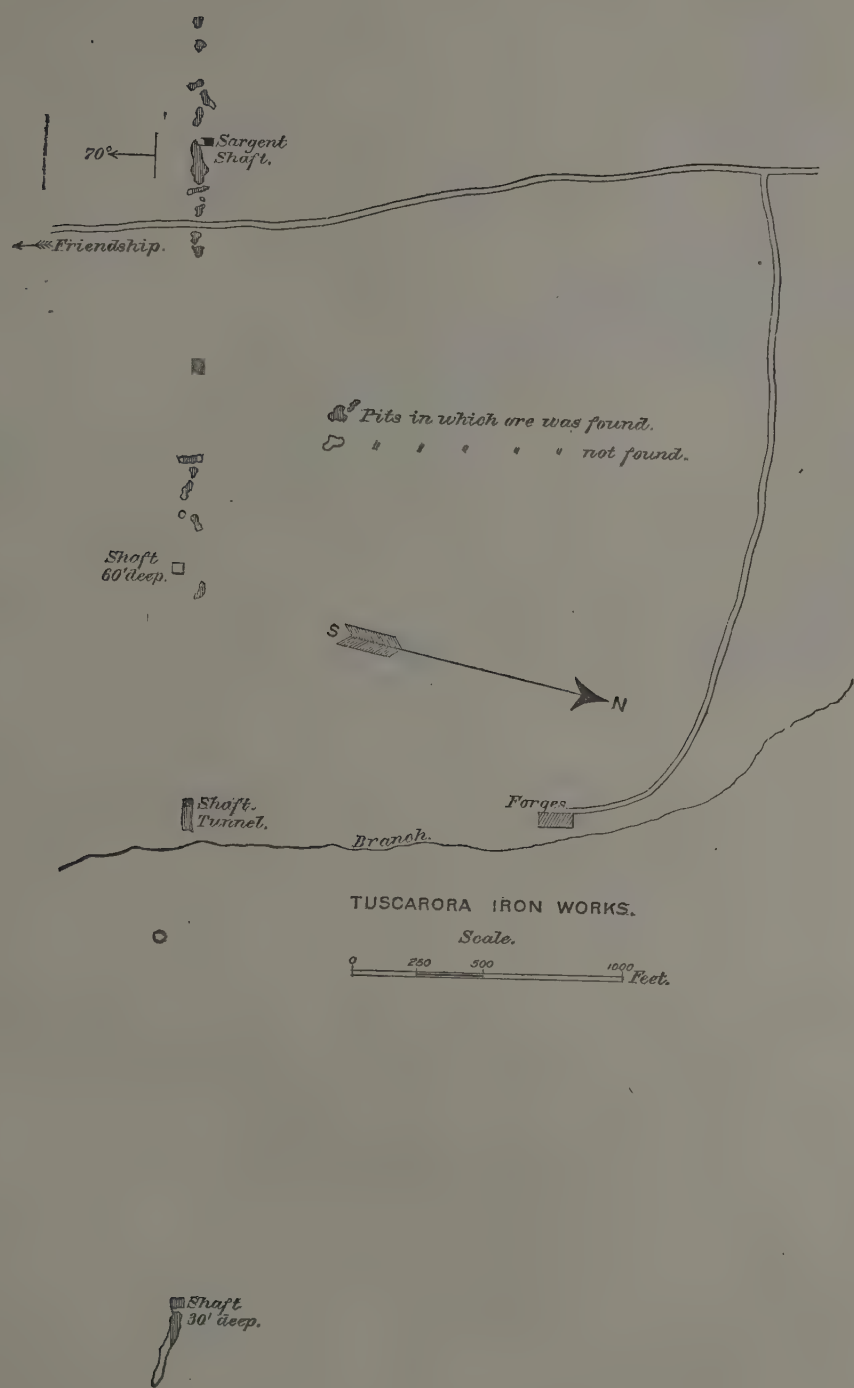

70°
Sargent Shaft.
Friendship.
Pits in which ore was found.
" " " " " not found.
Shaft 60' deep.
S
N
Shaft. Tunnel.
Forges
Branch.
TUSCARORA IRON WORKS.
Scale.
0 250 500 1000 Feet.
Shaft 30' deep.

FIG. 114.

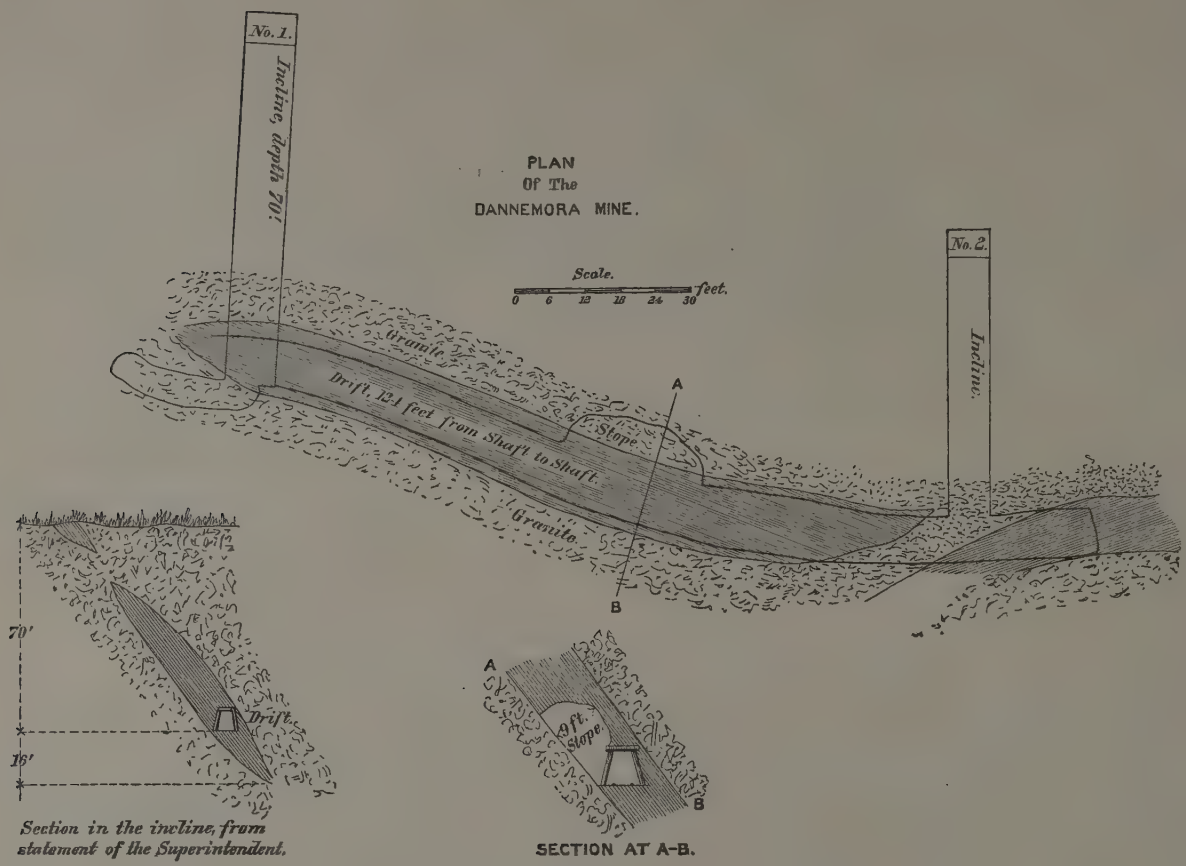


FIG. 115.

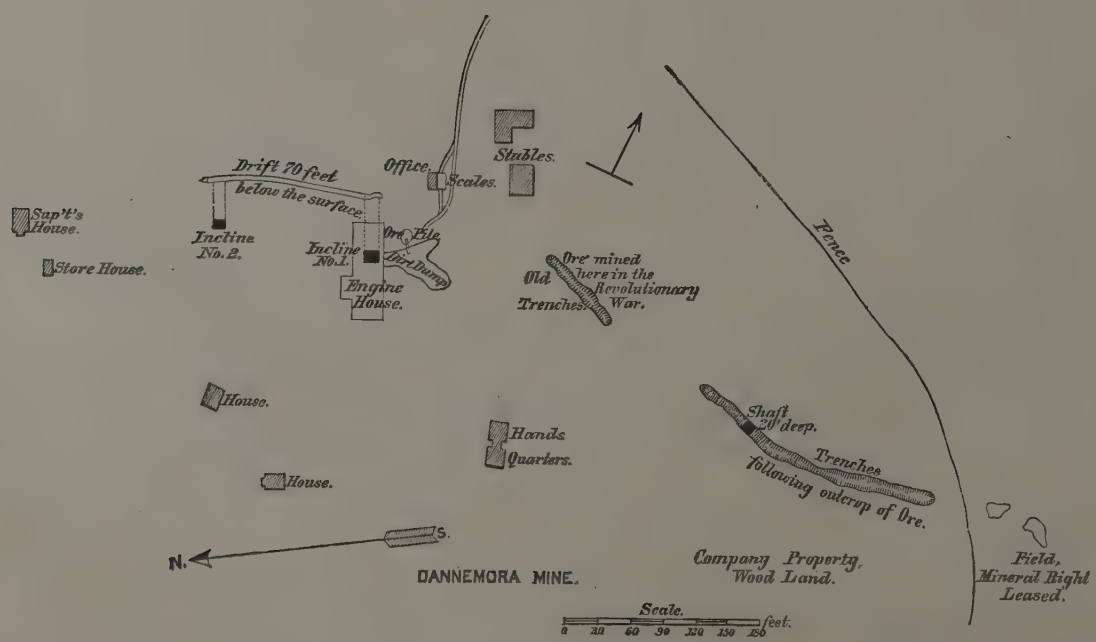


FIG. 116.

Following is the complete analysis of 165: a

	165.		165.
	Per cent.		*Per cent.*
Silica	4.70	Carbon in carbonaceous matter	0.06
Iron, protoxide	23.51	Hygroscopic water	0.21
Iron, sesquioxide	43.05	Water of composition	0.96
Alumina	8.66	Total	100.00
Chromium sesquioxide	0.34		
Manganese, protoxide	0.15	Per cent. of insoluble silicious matter	28.00
Lime	1.42		
Magnesia	2.96	Silica	4.70
Iron, disulphide	0.133	Alumina	9.75
Nickel, sulphide	0.01	Lime	0.56
Cobalt, sulphide	0.03	Magnesia	0.72
Copper, sulphide	0.01	Potassa	0.03
Potassa	0.03	Soda	0.05
Soda	0.05	Phosphoric acid	0.045
Carbonic acid	0.07	Titanic acid	11.82
Phosphoric acid	0.052		
Titanic acid	13.71	Total	27.675

b

There are two small areas of Huronian rocks in North Carolina, which carry magnetic ores, having similar c associations. The first of these is in the northern portion of the state, in Stokes county, in the neighborhood of Danbury; the second is in the southern part of the state, and extends from Catawba county, across Lincoln and Gaston, into York county, South Carolina. The ores of the former consist of mica, chlorite, and talcose schists, charged with magnetite; these are associated with silicious slates and itacolumite; talcose schist, similarly charged with magnetite, occurs throughout the entire length of the southern area, associated with silicious slates, and Professor Lieber mentions itacolumite as one of the members of the series in South Carolina (*Report for* 1856, p. 89). The strike of the rocks of the southern area is about north 10° to 15° east, dipping to the westward at a high angle. The dip in the northern area, which lies in the prolongation of the strike of the other, is toward the northwest and east at angles of 20° to 40°.

6. *Magnetic ores of Stokes and Surry counties.* d

This includes the ores of the Huronian, in Stokes county, already referred to, and similar magnetic ores, assigned by Professor Kerr to the Upper Laurentian, in Surry county.

The sketch (Fig. 117), drawn with the assistance of a gentleman well acquainted with the region, shows the location of the ore-beds in the neighborhood of Danbury, Stokes county. The question mark placed against several outcrops indicates that they were not visited by the writer, but are located from statements of others.

All the known beds lie north of the Dan river, with strikes ranging from northwest among the western deposits through north to north by east among the extreme eastern.

The *Hard-Ore* bank, so named on account of the hardness of the ore and associated hornblende schist, lies 4½ miles northwest of Danbury, on a small branch of Buck Island creek. e

The ore has been mined at different times on both sides of the branch at two points about 700 feet apart. The dip is about 40° north-northeast, and the bed therefore pitches with the hill on the south side of the branch; the ore was thus very easily obtained at this place, and there are extensive shallow pits now overgrown with trees twenty or thirty years old. The opening on the north side of the branch is a deep trench 50 or 60 feet long which extends under the overhanging bluff of hornblende schist; the vein is said to be 3 to 4 feet thick. It was followed downward until the influx of water and the hardness of the ore made it unprofitable to continue mining. The last work was done in this trench twenty-four years ago; no ore was to be seen in place, and sample 168 was taken from little pieces that were found near the trench, some of these contained pyrite.

f

	168.
	Per cent.
Iron	56.04
Phosphorus	None.

A small brook enters the Dan river just below the mouth of Buck Island creek; the hills on the east of this brook contain several beds of ore, known as the *Nelson* banks, and a shaft sunk on the ridge between the two streams is also said to have struck an ore-deposit.

Two out of the four leads of ore, said to have been found on Mr. Nelson's land east of the branch, are sufficiently well exposed to admit of no doubt as to their character; these are marked 179 and 180 on the sketch, the numbers

a representing the samples taken from them. Near the branch, in the fork of the roads toward the river, is a small pit from which ore is said to have been taken, and on the other side of the road, between the house and the barn, is a shaft of which the same statement is made. This pit and shaft represent, respectively, Mr. Nelson's western and eastern leads of ore.

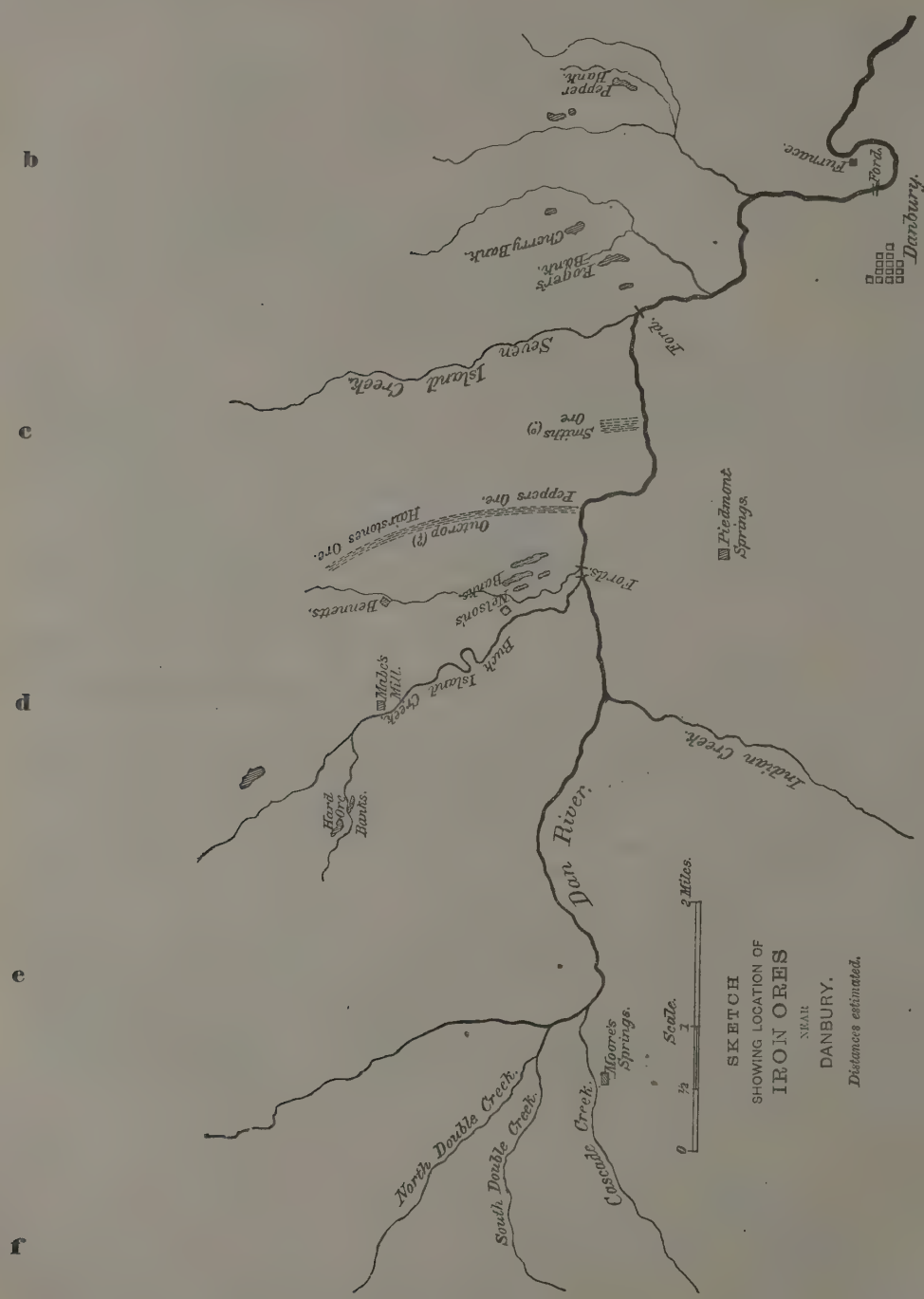


FIG. 117.

The range marked 179 consists of a soft talcose schist, which contains crystals of magnetite irregularly distributed through it. Nothing is known of its extent beyond the three openings shown in the sketch; the most northerly of these was specially cleaned out to get a sample of the ore, and the following section (Fig. 120) was thus exposed:

The sample is an average of the upper and lower beds:

	179.
	Per cent.
Iron	39.70
Phosphorus	0.040
Phosphorus in 100 parts iron	0.101

Nothing was to be seen in the five southern pits on the lead marked 180. The two northern ones were not so much fallen in, and pieces of ore were found near them from which sample 180 was taken. This range consists of hornblende or chlorite schist charged with magnetic ore. It is said it can be followed 2½ miles northwest by surface fragments.

	180.
	Per cent.
Iron	44.45
Phosphorus	0.015
Phosphorus in 100 parts iron	0.034

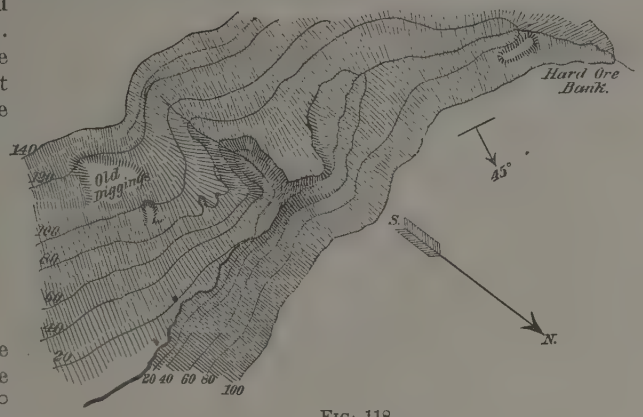


FIG. 118.

Both these ores are accompanied by pyrite which occurs in cubical crystals in the talcose schist just overlying. The strata dip about 40° east-northeast. Just east of Nelson's ores is the outcrop of the *Pepper* ore, and half a mile farther eastward lies *Smith's* ore. These deposits were not seen by the writer.

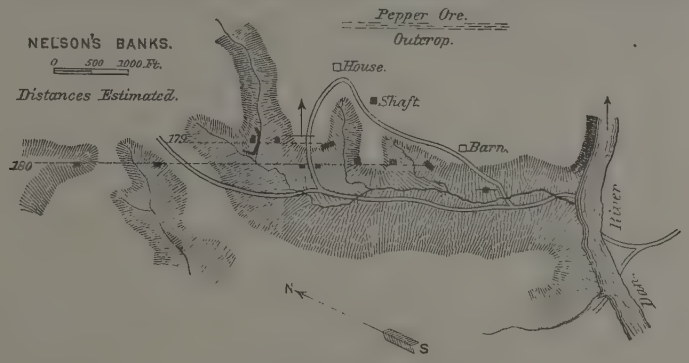


FIG. 119.

Next in order toward the east is the *Roger's* bank which lies near Seven Island ford, about 2½ miles north of Danbury. More work has been done at this bank than at any other; many years ago the outcrops and all the ore, to such depth as the rude pumps and other appliances permitted, were removed.

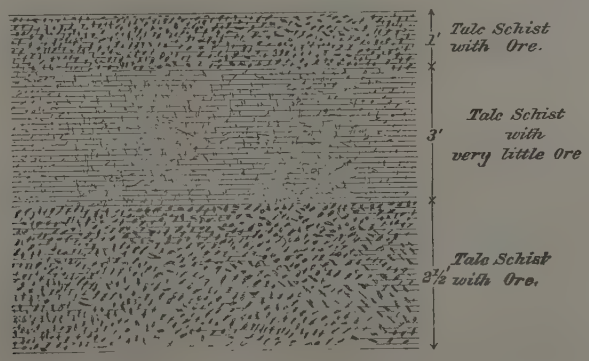
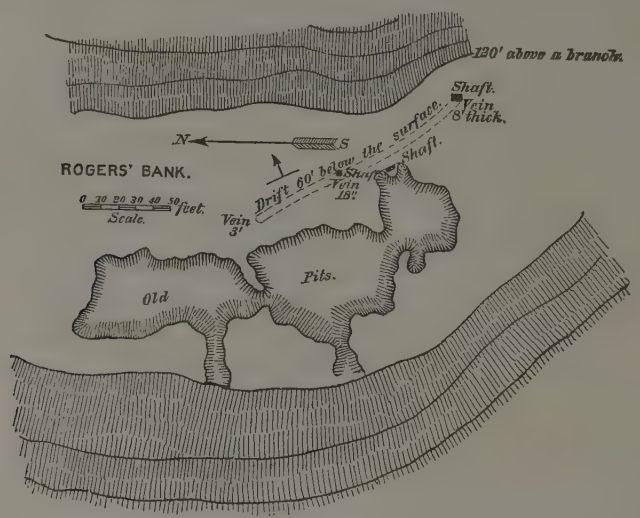


FIG. 120.—SECTION AT THE NELSON BANK, NORTH CAROLINA.

a During the late war the vein was followed in a tunnel at a depth of 60 feet; this tunnel is 150 feet long, and, as will be seen from the sketch, the thickness of the vein varies from 18 inches to 8 feet, the thinnest point being near the bottom of the main shaft; the dip is about 40° east by north. About 2 tons of ore were left near the main shaft in 1865; these had weathered down to an earthy pile, but by digging into it pieces of firm ore were

b



c

FIG. 121.

found, and the sample was taken from these. It is probable that this sample is richer in iron than the average, since the accompanying chlorite and mica would be the first to decompose. This ore also contains pyrite. The following is the analysis:

d

	No. 170.
	Per cent.
Iron	58.26
Phosphorus	0.001
Phosphorus in 100 parts iron	0.002

The complete analysis of No. 170 is as follows:

e

	170.		170.
	Per cent.		*Per cent.*
Sulphur	0.179	Carbon in carbonaceous matter	0.01
Phosphorus	0.001	Hygroscopic water	0.07
Iron, metallic	58.26	Water of composition	0.38
Silica	12.29	Total	100.168
Iron, protoxide	16.88		
Iron, peroxide	64.24	Per cent. of insoluble silicious matter	21.15
Alumina	0.58		
Lime	1.99	Silica	12.29
Magnesia	3.31	Alumina	4.34
Iron, disulphide	0.336	Lime	1.69
Carbonic acid	0.08	Magnesia	2.92
Phosphoric acid	0.002	Total	21.24

f

There are several test-pits in the neighborhood of the Roger's bank, in which parallel beds of ore are said to have been found; and the *Cherry* bank, which lies half a mile northeast, was quite extensively worked fifty years ago.

The *Pepper* ore-bank lies 2½ northeast of Danbury and about 1½ mile east of the Rogers bank. The ore, a granular magnetite, occurs disseminated irregularly through a mica-schist; the beds are conformable to the stratification of the schist, and are a portion of the original stratified deposit. The dip is about 40° southeast. It will be noticed that the dip and associations of this ore differ from those of the other deposits north of Danbury. The dip agrees with that of the Upper Laurentian rocks east of Danbury, as given by Professor Kerr (page 128 of *Geological Report* for 1875), and the ore is very like that of Surry county assigned by him to that age. The old works at this bank consist of several shafts and tunnels, now in a dangerous condition, and a trench about 150

yards long, which extends in a northeast and southwest direction. The thickness of the ore-bed 50 feet below the surface is stated at 12 feet. Sample 169 was taken from a stratum 1 foot thick, seen in one of the old tunnels. The following is the analysis:

	No. 169.
	Per cent.
Iron	43.92
Phosphorus	0.033
Phosphorus in 100 parts iron	0.075

The Upper Laurentian ores of Surry county are grouped with those just described in the arbitrary division adopted in this report. It has already been stated that the Pepper bank probably belongs to the same age as these ores, and what is said on page 314 of the occurrence of the magnetite at that bank applies equally well to the deposits of Surry county. The first of these deposits is the *Ferris* bank, near Hyatt's forge, on Tom creek, about 2 miles north of Pilot Mountain post-office. The irregular beds of ore dip with the stratified mica-schist, in which they occur about 30° to the north. A large quantity of ore has been taken out in small shafts and tunnels sunk to the water-level, about 20 feet. At this depth the ore becomes charged with pyrite and can no longer be worked in the forge. Two beds of ore, each about 2 feet thick, were seen in the shaft, which was open at the time the bank was visited; they were separated by about 1 foot of mica-schist. The upper bed is represented by sample 171, the lower by 172; the latter was taken out near the water-level. Sample 173 represents the mingled ore from these two beds after it has been stamped and washed in a rude trough, which only partially removes the associated minerals. Sample 174 was taken from the bottom of a shaft sunk below the water-level, about 100 feet from that in which 171 and 172 were seen. The following are the analyses:

	171.	172.	173.	174.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Iron	48.02	60.41	67.10	60.16
Phosphorus	0.094	0.073	0.056	0.051
Sulphur	0.106	0.112	0.133	1.956
Phosphorus in 100 parts iron	0.196	0.121	0.083	0.085

Similar ore is obtained about 200 yards southeast of this bank, and also 1 mile southeast at the *Bullington* bank, but none was to be seen when the locality was visited.

About 7 miles west of Pilot Mountain post-office, across the Ararat river, beds of magnetic ore occur in a sandy mica-schist, dipping about 20° a little west of north. These beds have been mined along a distance of about 1,000 feet in three parallel rows of shafts, sunk 15 or 20 feet apart, to a maximum depth of about 20 feet. One lenticular mass of ore, having a greatest thickness of 6 to 8 feet, has been entirely removed. The southern line of shafts seems to have struck a layer of ore which has not been reached in those north of it.

The following sketch shows the bed of ore from which sample 175 was taken:

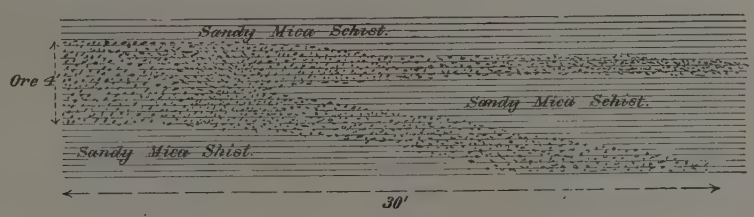


FIG. 122.

Sample 176 represents the same ore when stamped and washed for use in the forge.

	No. 175.	No. 176
	Per cent.	*Per cent.*
Iron	38.76	63.30
Phosphorus	0.049	0.033
Phosphorus in 100 parts iron	0.126	0.052

On the plantation of Mr. Jackson Williams, on the Fisher Gap road from Rockford to Mount Airy, about 3 miles north of Rockford, magnetic ore has been mined over an area of about 12 acres.

a The following are the dimensions of the principal ore-bodies, as given by Mr. Williams:

No.	Thickness perpendicular to strike and dip.	Length along the strike.	Remarks.
	Feet.	*Feet.*	
1	1	6	Removed to water-level.
2	3	5	Removed to water-level; underlies No. 1.
3	2	6	
4	8	17	Exhausted.

b

Similar deposits of ore occur in the ridges, which extend 1½ mile southwest and 2½ miles northeast of Williams's bank. There are six distinct banks along this line of 4 miles, of which the most northeasterly is the Poplar branch. Another lead of ore comes in half a mile west of Williams's at *Crowder's* and *Stanley's* banks.

Sample 177 is from a bed of ore at *Williams's* bank 3 inches thick, which was being followed as a lead. Sample 178 is from a body of ore at the *Poplar Branch* bank about 2 feet thick and 8 feet long.

The following are the analyses of the ore as mined:

c

	No. 177.	No. 178.
	Per cent.	*Per cent.*
Iron	45.28	56.08
Phosphorus	0.022	0.029
Phosphorus in 100 parts iron	0.049	0.052

Professor Kerr describes (page 257 of *Geological Report* for 1875) beds of ore in Yadkin and Davis counties which closely resemble the above. The mode of occurrence of these ores indicates that they formed a portion of the original sediments, which, after alteration, produced the micaceous sandstones; a form of deposit similar to that now making on the shores of Long island and in the "Black Sand" beach of Block island.

Limonite near Danbury.—The road, which leads west from Danbury along the northern slope of the Sauratown d mountains, crosses several localities where scattered surface fragments indicate the presence of limonite. At one of these places, 8 miles west of Danbury, there are several old trenches, near one of which is a small pile of ore. Sample 181 was taken from this pile and numerous surface pieces on both sides of the road.(*a*)

	No. 181.
	Per cent.
Iron	47.76
Phosphorus	0.690
Phosphorus in 100 parts iron	1.442

e 7. *Magnetic and limonite ores of Lincoln and Gaston counties, North Carolina, and York county, South Carolina.*

The first ores to be mentioned in this group are those of the Killian and Forney mines. These lie in Kerr's "syenitic" belt, assigned by him to the Lower Laurentian, about 5 miles north of Lincolnton, the Forney bank being about 2 miles east of Killian's.

The ore at these banks occurs in irregular pockets, a few inches to 3 or 4 feet thick, and of very uncertain length and depth. The strata stand nearly vertically. No work has been done at either mine below 20 feet.

At the *Forney* bank the line of shafts extends about 400 yards in a direction a little west of north.

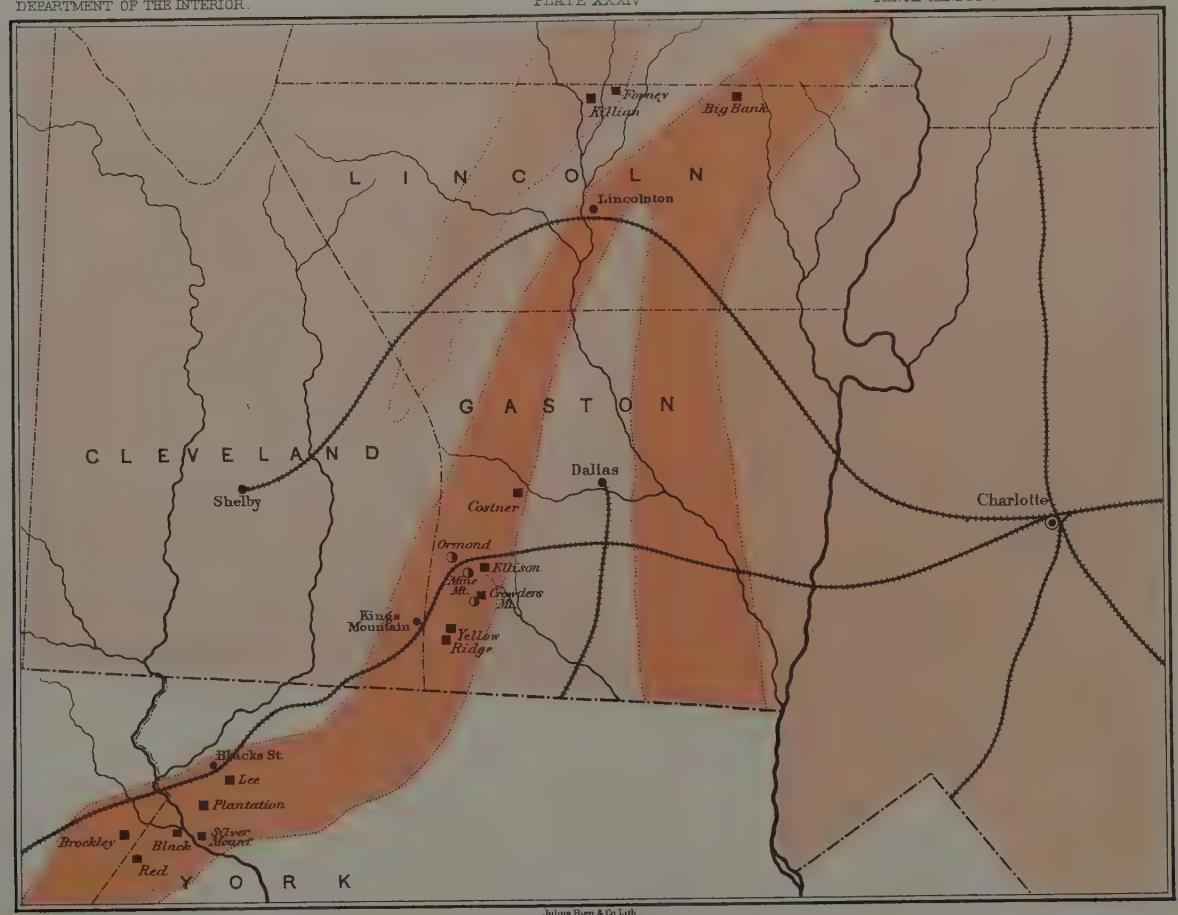
Sample 182 is from about four tons of ore freshly mined at the *Killian* bank at a depth of 20 feet, and sample 183 is from a pocket 3 feet thick at the Forney bank.

f

	No. 182.	No. 183.
	Per cent.	*Per cent.*
Iron	64.92	64.96
Phosphorus	0.036	0.009
Phosphorus in 100 parts iron	0.055	0.014

Huronian (?) magnetites.—These ores and their associated rocks are compared on page 311 with those in the neighborhood of Danbury, in Stokes county. The belt of Huronian strata in which the ores occur extends from Catawba county, North Carolina, to York county, South Carolina, and the distance between the extreme northern ore-bank, in Lincoln county, North Carolina, to the most southern, in South Carolina, is about 50 miles.

a The analysis shows that the ore contains a trace of titanium.



Julius Bien & Co. Lith.

IRON MINES OF GROUP SEVEN (NORTH AND SOUTH CAROLINA).

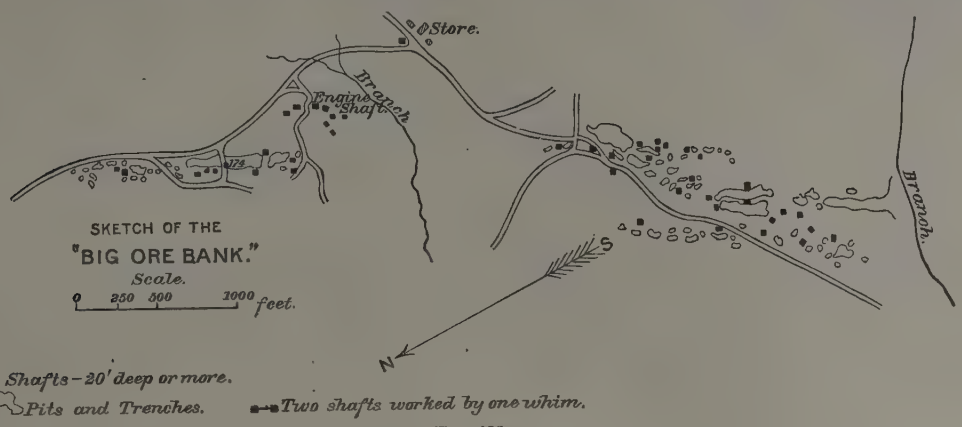
Huronian | Upper Laurentian | Lower Laurentian | Magnetite | Limonite

Drawn from Post Route Map and Kerr's Geological Map for 1875.

Scale, 8 miles = 1 inch.

The *Big Ore* bank lies on a broad ridge 9 miles north of Lincolnton, in Lincoln county. There are a large **a** number of shafts and trenches scattered in a very irregular manner along a distance of about 1 mile, in a general direction of north 15° to 20° east.

The accompanying sketch (Fig. 123) gives the approximate location of these various diggings, but it is difficult to form an idea of the manner of occurrence of the ore from such irregular workings. The mine was owned by a number of persons, any one of whom dug ore at pleasure, as water is drawn from a well, without keeping any record of it. When the ore found in one shaft was so far removed that it could no longer be shoveled into the bucket suspended from the windlass it was considered easier to sink a new shaft near the old one than to timber up a tunnel and transport the ore underground. These two facts account for the large number of little pits usually seen at an old ore-bank in the south, which often give rise to the idea that the amount of ore is very small and irregular in occurrence, an idea that may sometimes be erroneous. **b**



c

FIG. 123.

According to the statement of an old miner, the ore at the Big bank lies in lenticular masses, which overlap **d** each other, the southern end of one lying west of the northern end of the next. These ore-bodies consist of alternate layers of magnetic ore and talcose schist, and have a thickness of 8 to 20 feet, with a maximum length stated at 80 feet. The greatest thickness of any one stratum of clean ore is perhaps 2 feet; but such a layer is usually between two thinner ones of talcose schist impregnated with ore, so that the entire thickness would be mined out at once. As the strata stand nearly vertical there are apparently several parallel lines of ore-bodies. No ore was to be seen at the southern end of this bank, but some work had been done north of the little branch, and sample 184 was taken from about one ton, mined at a depth of 40 feet in the shaft so numbered. The analysis gives:

	184.
	Per cent.
Iron	58.38
Phosphorus	0.013
Phosphorus in 100 parts iron	0.022

e

The complete analysis of No. 184 is as follows:

	184.		184.
	Per cent.		*Per cent.*
Sulphur	0.086	Phosphoric acid	0.030
Phosphorus	0.013	Carbon in carbonaceous matter	0.01
Iron, metallic	58.38	Hygroscopic water	0.30
		Water of composition	1.01
Silica	9.14	Total	100.250
Iron, protoxide	8.68		
Iron, peroxide	73.67	Per cent. of insoluble silicious matter	14.32
Alumina	2.45		
Manganese, protoxide	0.06	Silica	9.14
Lime	0.27	Alumina	1.83
Magnesia	4.32	Lime	0.20
Iron, disulphide	0.140	Magnesia	3.17
Copper, sulphide	0.05		
Carbonic acid	0.06	Total	14.34

f

The engine shaft had been sunk during the late war to a depth of 80 feet. The thickness of the mass of ore thus opened was stated at 16 feet. When the bank was visited preparations were being made for pumping out and

a working this shaft, and the census schedules show that this has been accomplished and the mining of ore is now going on for the supply of a small charcoal furnace.

There are several openings of greater or less extent on the strike of the ore north of the Big bank. From the southern end of the latter to the most northerly of these is about 2½ miles, and such is the proximity of the different banks that the range of ore may be considered to be nearly continuous for this distance. A portion of the ore of the Big bank is changed to martite.

About 22 miles from the Big Ore bank, in a general direction of south 25° or 30° west, is the *Costner* bank, the most northerly of a series of beds in Gaston county whose characteristics are the same as those of the range just described. A shaft was sunk during the late war at the Costner bank to a depth of 115 feet, and the thickness of the vein thus opened was stated at 7 feet. Several piles of ore, left near this shaft 15 years ago, had weathered b down into earthy mounds, within which were found a few lumps of ore which still retained their form. Sample 185 is from these lumps. A small quantity of a very different ore, called "flint" by the workmen, was taken out in sinking the deep shaft. This is represented by sample 186.

	185.	186.
	Per cent.	*Per cent.*
Iron	51.75	44.82
Phosphorus	0.002	0.004
Phosphorus in 100 parts iron	0.004	0.009

c

The relation existing between these two ores could not be ascertained.

The *Ellison* bank is about 4 miles south by west from the Costner, and is similar in its ore and associations. It lies half a mile from the railroad, between Charlotte and Atlanta, within 50 feet of the road from King's mountain to Dallas. The greatest depth reached at this bank is 112 feet, and the vein varied from 5 to 12 feet in thickness, with an average of 7 or 8. The outcrop has been removed for about 100 yards. Sample 187 is from small pieces of ore, picked up around the old trenches and pits.

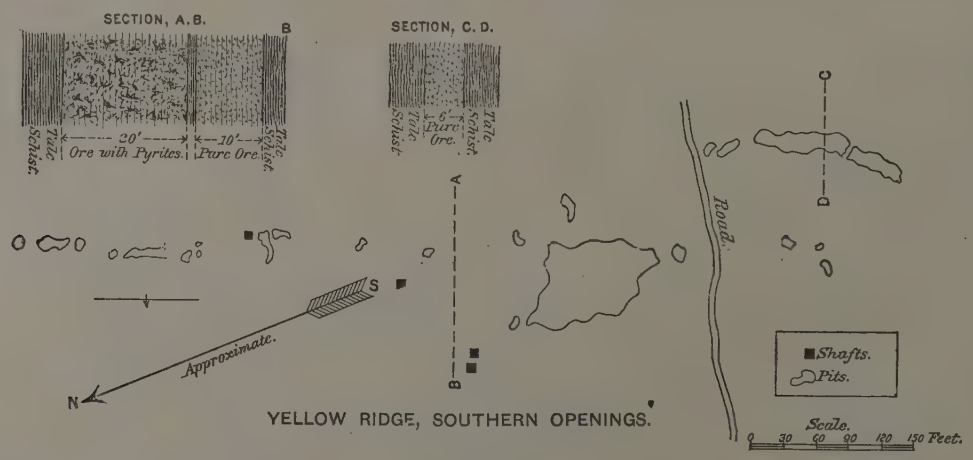
d

	187.
	Per cent.
Iron	54.61
Phosphorus	0.016
Phosphorus in 100 parts iron	0.029

The same range of magnetic ores, disseminated through talcose schist, has been quite extensively worked on the *Yellow Ridge*, 4 miles south by west from the Ellison bank, and 2½ miles east of King's Mountain Station. There are two groups of pits and trenches on the ridge, about one-quarter of a mile apart. At the northern workings the bed is said to be 6 to 10 feet thick, at a depth of about 30 feet. Sample 193 is from a few pieces of ore found near the old whim-shaft.

e

f



YELLOW RIDGE, SOUTHERN OPENINGS.

FIG. 124.

The deposit, opened in the southern end of the ridge, consists of two parts, separated by a layer of talcose schist, containing no ore. The western side of the bed is said to be 20 feet thick, and contains a large amount of pyrite. The eastern side is 10 feet thick, and is free from pyrite. A hundred yards farther south the ore narrows to 6 feet, and the portion of the bed that is contaminated with sulphur has dissappeared. This is shown in the sketch and sections on Fig. 124.

Sample 191 is from a pile of the ore containing pyrite; 192 is from a few large pieces of pure ore found near a the shaft; and 193 is from the northern openings.

	191.	192.	193.
	Per cent.	*Per cent.*	*Per cent.*
Iron	57.64	57.43	59.24
Phosphorus	0.009	0.010	0.030
Sulphur	0.441	0.101	.....
Phosphorus in 100 parts iron	0.016	0.017	0.051

Twelve miles southwest of the Yellow ridge, in York county, South Carolina, are the northeastern openings b of the King's Mountain Iron Company's mines, which, together with those of the Cherokee Company, open up this same range of ores for about 6 miles.

Passing from northeast to southwest the principal banks are the *Lee*, *Plantation*, and *Stewart*, east of Broad river, and the *Brockely*, west of it. The strata dip about 40° southeast, and the strike is northeast and southwest.

The Lee bank has been very extensively worked along a line of about 6,000 feet, to a greatest depth of 45 feet. The deepest shaft is one-half mile southeast of Black's station, on the railroad between Charlotte and Atlanta. The bed exposed in this shaft is said to widen from 3 or 4 inches at the top to 8 feet at the bottom.

Sample 199 is from a large number of pieces of ore picked up near the old trenches of the southern 1,500 feet of the bank. c

It is about 3 miles from the southern end of the Lee bank to the Plantation, of which the Stewart is merely a continuation. The ore-beds are said to be smaller and not as rich as those of the Lee bank, and the openings are not so extensive.

Sample 200 is from about 2 tons of ore mined at the Plantation bank several years ago. The analyses are:

	199.	200.
	Per cent.	*Per cent.*
Iron	52.16	54.65
Phosphorus	0.014	0.002
Phosphorus in 100 parts iron	0.027	0.004

d

The openings at the Brockley bank, of which the following is a sketch (Fig. 125), appear to indicate the

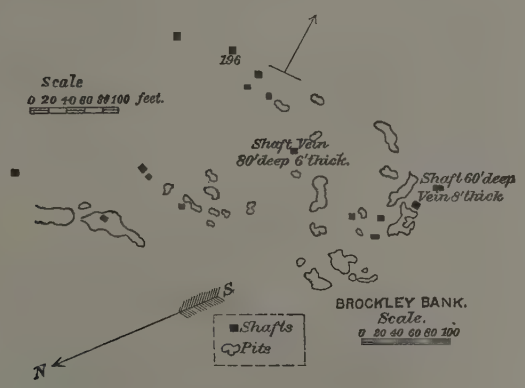


FIG. 125.

existence of several parallel beds of ore.

This bank lies about 2 miles from the railroad.

Sample 196 is from about 1 ton of ore, mined several months before at a depth of 60 feet, in the shaft marked f with that number.

	196.
	Per cent.
Metallic iron	58.34
Phosphorus	0.011
Phosphorus in 100 parts iron	0.019

The above description includes all the principal banks on the range of the so-called "gray ores". There are several others in close proximity to these, which differ from them in their general character.

a Two of these banks lie west of Broad river; one 1½ mile south of the Brockley bank, the other at Cherokee ford, 2 miles east of the same point. The former is known as the "red ore", the latter as the "black". The "red ore" consists of magnetite or martite, impregnating a silicious schist. There are three openings upon it, two of them close together, the other half a mile off to the northeast. Sample 197 was taken at the latter opening from about 3 tons of ore mined there some years ago. Nothing could be learned concerning the thickness or general character of the ore-beds.

The ore at the *Black* bank, near Cherokee ford, consists of magnetite, in lenticular masses a few inches to 2 or 3 feet thick, or impregnating the accompanying chlorite schist. The dip of the ore and schist is about 40° to the southeast, and the openings extend about 400 yards along the strike. No work has been done beyond 15
b feet below the surface. No satisfactory sample of this ore could be obtained. A pile of very poor ore was all that could be found, and from this sample 198 was selected.

The following is the analysis of the sample 197:

	197.
	Per cent.
Iron	37.79
Phosphorus	0.172
Phosphorus in 100 parts iron	0.455

c Sample 198 not analyzed.

The *Silver Mountain* bank is opened on a friable bluish-gray ore, consisting of martite in a silicious schist, about 1 mile south of the Plantation bank. The diggings extend for about half a mile in a northeast and southwest direction across the summits of two hills, which border on the Broad river. Sample 401 is from a bed of ore about 3 feet thick, which dips toward the southeast. The analysis gives:

d

	401.
	Per cent.
Iron	39.24
Phosphorus	0.180
Silica	36.67
Phosphorus in 100 parts iron	0.459

The Costner, Ellison, and Yellow Ridge banks, near King's mountain, in Gaston county, North Carolina, have already been described. East of this range, on the summit of *Crowder's* mountain, is an outcrop of coarsely granular martite, and somewhat lower down is a bed of limonite. Crowder's mountain rises about 1,000 feet above the surrounding country, and is crowned by a bold ridge 50 to 100 paces wide, limited on the east and west by precipices. The northern spur is particularly wild and rugged. The southwestern slope from the summit, though very steep, is less broken, and it is on this that the martite crops out, as shown on the sketch (Fig. 126). The principal

e

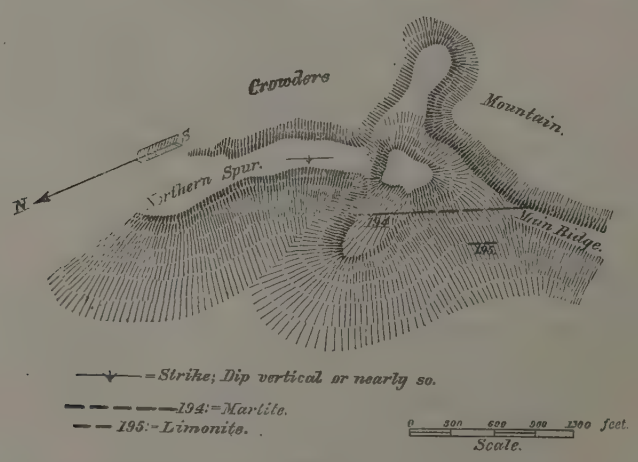


FIG. 126.

exposure is under the roots of a pine tree near the point marked 194. Here the bed of ore is 2½ feet thick. Sample 194 is from this point.

The only other outcrop is on the main ridge and is very small; but surface fragments were found along the a hillside across the entire 1,200 feet between the two.

The associated rocks are highly silicious slates, which stand vertically, with a strike of north 15° or 20° east.

But little could be learned concerning the limonite represented by sample 195.

About a ton of the ore was piled up near an old trench, at the place designated by that number on the sketch, and the sample was taken from that. Nothing was seen in place.

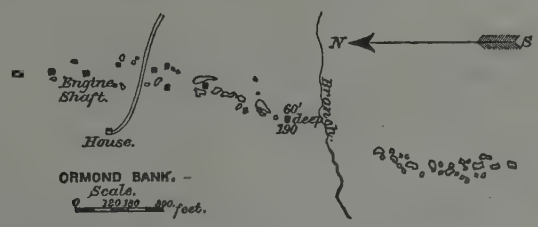
It is said that there are three other beds of ore on the northern spur of the mountain, but their exact location was not known to any one seen by the writer.

	MARTITE.	LIMONITE.
	194.	195.
	Per cent.	*Per cent.*
Metallic iron	50.39	55.17
Phosphorus	0.020	0.604
Phosphorus in 100 parts iron	0.040	1.095

b

Four and a half and 5 miles northeast of King's Mountain Station, near the Piedmont Air-Line railroad, are two interesting deposits of ore, which do not appear to belong to the regular formations hitherto considered. c

The first of these is the *Ormond* bank, which lies about 500 yards west of the railroad. The openings at the bank extend about 1,500 feet in a direction of about north 20° east; the greatest depth, 80 feet, was reached in the engine-shaft.



d

FIG. 127.

The ore was said by an old miner to lie in lenticular masses 3 to 8 feet in thickness, the southern end of one, lying east of the northern end of the one beyond it.

About two tons of ore were found near the shaft marked 190 on the sketch, and the sample of that number was taken from them. This pile contained two kinds of ore intimately associated in the same pieces; the first is very dense, hard enough to scratch glass, has a brown streak like limonite, and is distinctly magnetic; it is not at all granular, and in appearance closely resembles many of the dense homogeneous limonites. The other is dark e colored, fine grained, and slightly friable; it shows lamination, has a very dark almost black, slightly reddish streak, and is also magnetic. The two occur in such intimate association, that but one sample was taken from the pile.

The analysis of this gives:

	190.
	Per cent.
Iron	65.82
Phosphorus	0.092
Phosphorus in 100 parts iron	0.140

The second deposit is known as the *Mine Mountain*. It lies about half a mile east of the railroad on a spur of Whetstone mountain, three-quarters of a mile from the Ormond bank. f

The ore is limonite altered from siderite or calcite; portions of it are mamillary and stalactitic, but the greater number of specimens show pseudomorphs after rhombohedra. It incloses large crystals of quartz, sometimes 3 inches through, whose surfaces bear the impressions of rhombic crystals. Associated with this limonite is an earthy friable ore, which also shows pseudomorphs after rhombohedra, but has a dark-reddish streak, and is apparently manganiferous.

These ores occur in a vein, 8 to 10 feet wide, with vertical walls of silicious slate. An open cut 20 feet deep and trenches extending to a distance of 100 feet are the only workings. The strike is about north 30° east.

Samples 188 and 189 represent the limonite and manganiferous ore, respectively; they were taken from two piles of about 10 tons each at the bank.

a Besides the quartz crystals which the ore contains, there are others of apatite of such size that they could be separated by hand-picking and they were not included in the samples.

	188.	189.
	Per cent.	*Per cent.*
Metallic iron	61.00	58.37
Phosphorus	0.009	0.005
Phosphorus in 100 parts iron	0.015	0.009

Following are the complete analyses:

b

	No. 188.	No. 189.
	Per cent.	*Per cent.*
Sulphur	0.090	0.112
Phosphorus	0.009	0.005
Iron, metallic	61.00	58.37
Silica	1.63	5.28
Iron, protoxide	0.24	0.29
Iron, peroxide	86.75	82.92
Alumina	0.25	1.33
Manganese, protoxide	1.00	4.11
Lime	0.24	0.52
Magnesia	0.13	0.16
Iron, disulphide	0.169	0.211
Nickel, sulphide	Trace.	Trace.
Cobalt, sulphide	Trace.	Trace.
Copper, sulphide	Trace.	Trace.

c

	No. 188.	No. 189.
	Per cent.	*Per cent.*
Carbonic acid	0.15	0.14
Phosphoric acid	0.023	0.017
Carbon in carbonaceous matter	0.06	0.03
Hygroscopic water	0.33	0.62
Water of composition	9.30	4.24
Total	100.272	99.868
Per cent. of insoluble silicious matter	1.63	5.59
Silica	1.63	5.28
Alumina	Trace.	0.26
Lime	Trace.	0.14
Total	1.63	5.68

8. *Limonite near Hickory, and magnetite and specular ores of Caldwell county, on the Upper Yadkin river.*

These ores are grouped together simply for convenience of enumeration; they possess no characteristics in d common, and have different geological relations.

e

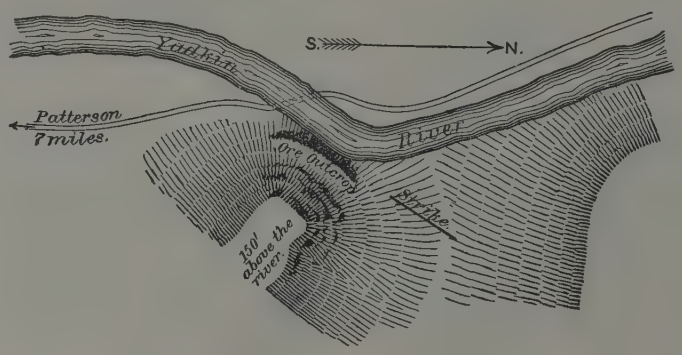


FIG. 128.—SKETCH OF THE OUTCROP OF TITANIFEROUS MAGNETITE ON THE UPPER YADKIN RIVER, NORTH CAROLINA.

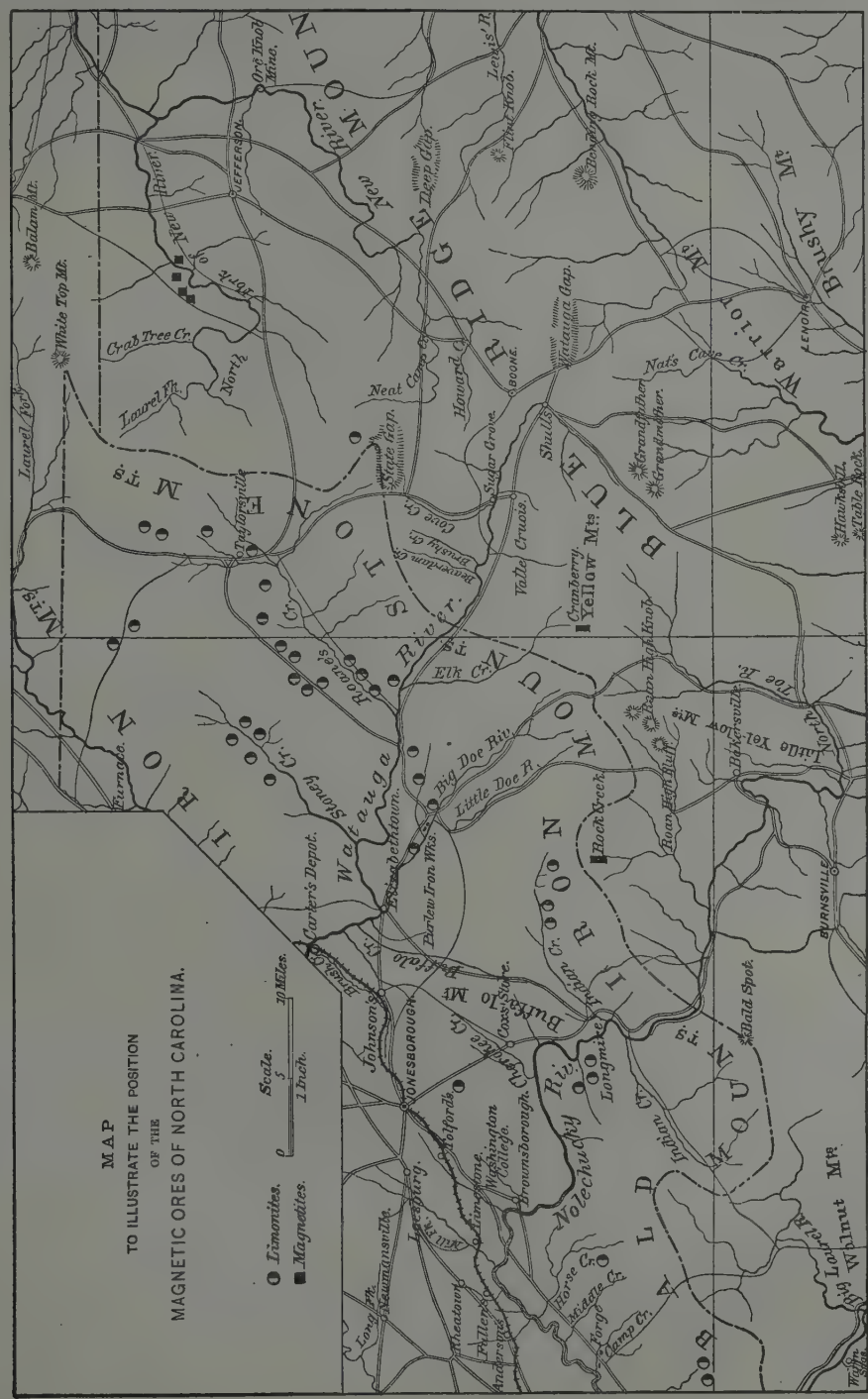
The farm of Mr. N. Propst lies a quarter of a mile north of the Western North Carolina railroad, very near the eastern boundary of Burke county. A bed of limonite was opened many years ago in a field close by his house, and the ore is said to have been quite extensively used. All the old pits are now filled up, and sample 404 was taken from scattered pieces of ore found in the field. Surface pieces indicate the extension of the bed of ore in a f northeast and southwest direction for about half a mile, the line crossing the railroad; and about 4 miles southwest of Propst's similar ore used to be dug, at Mrs. Townsend's. The analysis of sample 404 gives—

	404.
	Per cent.
Iron	54.84
Phosphorus	1.357
Phosphorus in 100 parts iron	2.474

The age of this ore, according to Kerr, is Upper Laurentian.

The Yadkin river above Patterson is a clear mountain stream, sometimes closely hemmed in among the spurs of the Blue Ridge, sometimes bordered by a narrow strip of bottom-land.

The farm of Mr. Curtis is on the river about 7 miles from Patterson, where the valley, a quarter of a mile in width, is bounded by wooded hills 150 to 200 feet high. The road crosses the river at a bend close to a bluff of chlorite schist about 20 feet high. This schist contains grains of a titaniferous mineral that has a black streak, a metallic luster, and is very slightly magnetic.


MAP
TO ILLUSTRATE THE POSITION
OF THE
MAGNETIC ORES OF NORTH CAROLINA.
Scale.
5 10 Miles.
1 Inch.
Limonites.
Magnetites.
Balsam Mt.
White Top Mt.
Laurel Fk.
Grab Tree Cr.
North Fork
New River
Pattersville
Ore Knob Mine.
JEFFERSON
New River
Lewis R.
Fine Knob.
Big Rock Knob Mt.
Neat Cove Cr.
Howard Cr.
Sugar Grove
SHULL'S
BOONE
Nat's Cove Cr.
Grandfather
Grandmother
Hawksbill
Table Rock
Cranberry
Yellow Mts.
Valley Crucis
Elk Cr.
Big Doe Riv.
Little Doe R.
Rock Creek
Little Yellow Mt.
Five R.
BURNSVILLE
Bald Spot.
Wataugа River
Roaring Fork
Sovoy Cr.
Clarke's Depot.
Bartew Iron Wks.
Johnson's
JONESBOROUGH
Bufalo Mt.
Nolechucky Riv.
Longmire
Fabian Cr.
Walnut Mts.
Leesburg.
Rheatown
Anderson
Horse Cr.
Hemp Cr.
Brownsborough.
Washington College.
Limestone
Kelford
Leitersville
Long Fk.
Neumansville.
Furnace.
Pleasant Hill
Lake Cr.
Cobb Cr.
Cranberry Cr.
Big Limestone Cr.
Dry Cr.
Lick Cr.
Deep Cr.
Lewis Cr.
Pleasant Grove
Valley Cr.
Bluff Cr.
Bear Cr.
Big Cr.
Little Cr.
Cove Cr.
Dry Cr.
Pleasant Grove
Mt. Pleasant
Mt. Pleasant
Mt. Pleasant

a Dennis creek, one of the small streams running into the Yadkin river near its source, flows through a narrow valley called the "Richlands", which comes to an end among the high spurs of the Blue Ridge, near the Watauga and Caldwell county line. Near the head of the creek, just over the line in Watauga county, are several open cuts in a very steep hillside, which were dug in search of specular ore. The rock is principally a light-gray slate, which is thickly sprinkled with crystals of magnetite, and is accompanied by layers of specular schist one-fourth to 1 inch thick.

At Bull Ruffin, 4 miles northeast of this point, the same ore is said to crop out in a bed 1 foot thick, and it is also stated that it can be traced nearly continuously from the one locality to the other.

Sample 406 was taken at the head of the Richlands; it was not easy to separate the thin layers of ore entirely from the associated schist, and it is possible that a larger bed, if found, would yield a higher percentage of iron.

b The analysis gives—

	406.
	Per cent.
Iron	44.45
Phosphorus	0.012
Phosphorus in 100 parts iron	0.027

9. *Magnetic ores of Ashe, Mitchell, and Madison counties.*

Ashe county.—The location of the ores sampled in Ashe county is shown on the accompanying sketch (Fig. 130):

c

d

e

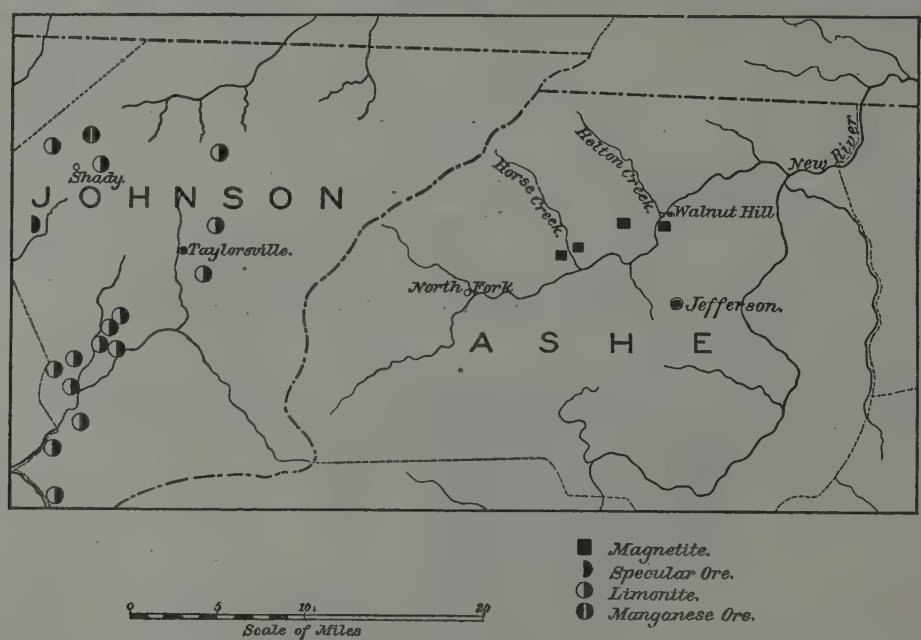


FIG. 130.—MAP OF PARTS OF JOHNSTON AND ASHE COUNTIES, NORTH CAROLINA, SHOWIMG LOCALITIES OF IRON ORES.

The first deposit seen is that on *Horse creek*, half a mile above its mouth, on the lands of J. and C. Graybeal and F. S. Hampton. The ore is a magnetite, which occurs in coarse crystals, associated with hornblende and mica. Thirty years ago it was mined on the farm of Mr. Joseph Graybeal and worked in a forge near by; but the old pits are now filled up, and only weathered surface-pieces of ore are to be seen. These present a peculiar honeycombed appearance, on account of the removal of the accompanying minerals, which have left a nearly pure magnetite f behind. Sample 942 was taken from a large number of such pieces which were scattered over a steep hillside. It is possible that some portions of the ore may be as rich as this sample, for the proportions of foreign minerals vary very much in all similar ores of this region; but it is probable that sample 941, taken from ore dug in a small pit on Hampton's land, 1 mile northeast of Graybeal's, represents more nearly the average yield of the bed. Nothing could be seen or learned concerning the thickness of the bed or its general character. It was not definitely ascertained that the ores at Hampton's and Graybeal's belong to the same bed; it is possible there may be two parallel belts. The above samples contained—

	941.	942.
	Per cent.	*Per cent.*
Iron	51.66	63.80
Phosphorus	0.019	0.009
Phosphorus in 100 parts iron	0.037	0.014

The *Poison Branch* bank lies about 1 mile from New river and 2 miles from the mouth of Helton creek, 3 or 4 a
miles east of Graybeal's. The bed, exposed in an open cut, consists of two parts. The upper is 1 foot thick, and consists of mica-schist, which incloses large crystals of magnetite; it is much decomposed and is quite soft. Immediately beneath it is a hard, fine hornblende schist 2 feet thick, which is also impregnated with magnetite.

Sample 943 represents the upper and 944 the lower part of the bed, both taken at the bank from the ore in place. The following are the analyses:

	943.	944.
	Per cent.	*Per cent.*
Metallic iron	62.78	50.63
Phosphorus	0.041	0.016
Sulphur	1.000	0.076
Phosphorus in 100 parts iron	0.065	0.032

b

Another deposit of magnetic ore, associated with hornblende, has been opened on the land of Mr. N. B. Ballow, on the south side of New river, a mile above the mouth of Helton creek. No mining has been done, but the bed has been uncovered, exposing 12 feet of ore, with a thin parting of hornblende and quartz in the middle. On the other side of the river, a quarter of a mile from this exposure, the bed crops out about 1 foot thick, on much lower ground, and on another hill a little farther southwest it is 3 or 4 feet thick. c

Sample 945 was taken from the bed on the south side of the river. The analysis gives:

	945.
	Per cent.
Iron	48.92
Phosphorus	0.018
Phosphorus in 100 parts iron	0.037

Southeast of the iron ore, close to the river, Mr. Ballow has uncovered a bed of peculiar graphitic gneiss, 2½ to d
3 feet thick.

The *Cranberry* ore-bank is the best known and most typical of the deposits of magnetic ore in western North Carolina. It lies on one of the northern spurs of the Big Yellow mountain just west of Cranberry creek.

The following sketch, taken from *Kerr's Report* for 1875 (p. 264), gives the general outlines of the deposit and the contours of the steep ridges, upon which are located the shallow diggings that have furnished ore for the Cranberry forge. No mining has ever been done and all the old pits, except those on the southeastern pitch, marked 407, 408, and 409, are caved in; in the absence of outcrops the limits of the bed have therefore to be determined by the distribution of surface fragments. These are found, as shown by Professor Kerr, on the highest ridge, and are more or less thickly scattered over the hillside down to the creek. (*a*)

At the time the bank was visited, April, 1880, there were several cuts extending around the hill at about the e
60- to 75-foot contour line from the road on the southwest to the little brook; there were also several openings on the other side of the brook in which the ore was exposed.

In the section thus formed the mass of ore south of the brook consists of pyroxene, accompanied by magnetite; contained in this mass are small pockets or veins of very pure, dense, coarsely crystalline magnetite 1 to 2 feet thick. There are also very similar pockets of pyroxene, which breaks out in sharply angular pieces. North of the brook the pyroxene is largely replaced by epidote. At the opening marked 409 pure ore, pyroxene with ore, and epidote with ore may be seen in close contact in irregular bunches, having no well-defined limits.

Samples 407, 408, 409, and 410 represent respectively the pure magnetite, the pyroxene with magnetite which forms the mass of the ore, the epidote and magnetite, and the pure pyroxene. They were each taken as averages of the exposed rock at the points designated by their respective numbers on the sketch: f

	407.	408.	409.	410.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sulphur	0.115	0.128	0.128	.....
Phosphorus	0.004	0.007	0.010	0.009
Metallic iron	64.64	44.08	32.37	24.01
Phosphorus in 100 parts iron	0.006	0.016	0.031	0.037

a Since this locality was visited a railroad has been completed to Cranberry, and extensive mining operations are now in progress.

a Following are the complete analyses of 407 and 409:

	No. 407.	No. 409.
	Per cent.	*Per cent.*
Silica	5.27	29.99
Iron, protoxide	26.68	18.93
Iron, peroxide	62.57	25.05
Alumina	1.18	10.07
Manganese, protoxide	9.22	0.76
Lime	1.46	11.33
Magnesia	0.55	1.78
Iron, disulphide	0.200	0.180
Nickel, sulphide	0.04	0.09
Carbonic acid	0.08	0.07
Phosphoric acid	0.007	0.024
Titanic acid	0.95	.....
Hygroscopic water	0.35	0.37
Water of composition	0.49	1.49
Total	100.047	100.134

b

	No. 407.	No. 409.
	Per cent.	*Per cent.*
Per cent. of insoluble silicious matter	7.20	43.69
Silica	5.27	29.99
Alumina	1.41	4.63
Lime	0.52	4.62
Magnesia	0.26	0.56
Ferrous oxide	.....	3.78
Potassa	.....	0.10
Soda	.....	0.07
Total	7.46	43.75

c

d

e

f

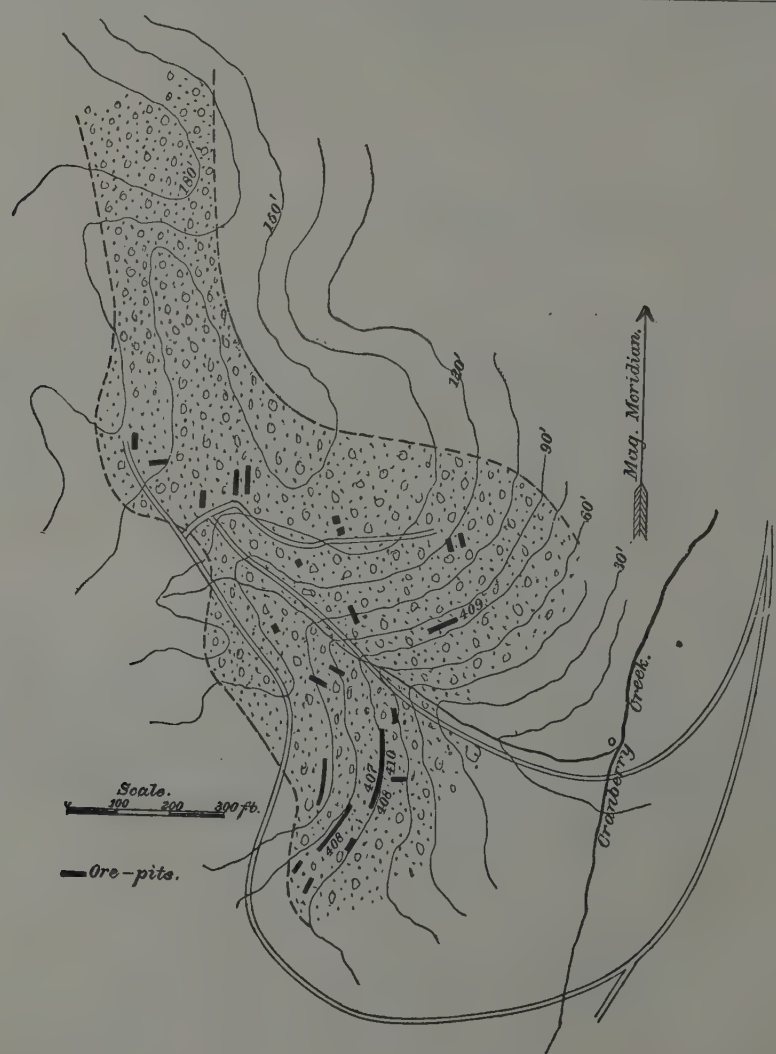


FIG. 131.—SKETCH OF THE CRANBERRY ORE-BANK, NORTH CAROLINA. From *Kerr's Report* for 1875.

Big Rock creek, one of the tributaries of Toe river, in Mitchell county, gathers its waters from the western slopes of the Great Roan and the southern and eastern sides of Iron mountain. These ranges, together with their

bold spurs, that rise from 1,000 to 3,000 feet above the creek, form a number of converging mountain valleys, **a** several of which meet near Cloudland post-office. Three miles north of this point, on the steep hillside west of Greasy creek, there is a small open cut, in which a bed of very pure, rich magnetite is exposed. The ore is very similar in appearance to the pure ore of Cranberry, and has a thickness of 5 to 8 feet. The ridge, upon which it is found, extends in a course of about south 15° west to Cloudland, where it is cut through by the most western of the streams that meet there, and then continues in about the same direction for some miles. It is said that this ore has been traced by surface-pieces to a distance of 15 miles along this ridge from the open cut first described. Widely-scattered fragments of epidote, which cover the hillside, indicate that here, as at Cranberry, it is one of the associates of the magnetite, though none of it was seen in the ore itself.

Sample 411 was taken from about 1 ton of the ore at the pit above Greasy creek. The following is the analysis: **b**

	411.
	Per cent.
Iron	63.36
Phosphorus	0.012
Phosphorus in 100 parts iron	0.019

Another bed of magnetic ore, whose associations and character prove it to be closely related to those just described, has been opened on Big Ivy creek, in Madison county, 3 miles from the French Broad and 12 miles from Asheville. This opening **c** is on the land of Mr. Ellers, on a steep hillside, within 200 yards of the creek. It is a trench, about 15 feet deep and 35 feet long, dug at right-angles to the ore-bed, which strikes about northeast. The following is the section thus exposed (Fig. 132):

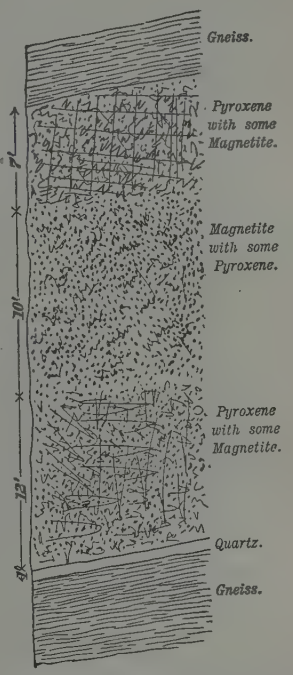


FIG. 132.—SECTION OF ORE DEPOSIT AT BIG IVY CREEK, NORTH CAROLINA.

In this section the proportions of magnetite and pyroxene vary considerably, and the belts, indicated on the sketch, are not separated by sharply-defined lines. But the preponderance of pyroxene at the sides, for the widths given, is such as to warrant the statement that the ore, rich enough to bear transportation, has not a greater thickness than 10 feet.

Sample 412 was taken from the central 10 feet of the bed in the trench. The following is the analysis: **d**

	412.
	Per cent.
Iron	42.95
Phosphorus	0.005
Phosphorus in 100 parts iron	0.012

10. *Limonite of Cherokee county.*

Professor Kerr gives, on pages 269 and 270 of his report for 1875, a somewhat detailed description of the three **e** parallel limonite belts on Valley river and southeast of it, and of their associates, marble, steatite, quartzite, mica-schist, and gneiss. The writer was unable to follow out the details of the section given by him, but he visited and sampled the five most important mines, including all three ranges. The location of these points is given on the accompanying sketch (Fig. 133), each one being indicated by the number of the sample taken there:

The first place visited is on the property of Mr. Morse, in the valley of Valley river, 10 miles northeast of Murphy. The bed seen at this point was about 8 feet wide, with a strike nearly east and west, at an angle with the general strike of the range. The ore is compact and hard, with nodules filled with clay and some softer, more earthy portions.

Sample 413 is an average of the entire face of ore exposed, which was 8 feet wide by 6 feet high. The analysis gives— **f**

	413.
	Per cent.
Iron	57.84
Phosphorus	0.021
Phosphorus in 100 parts iron	0.036

Three miles southwest of Mr. Morse's bank, on the same general range with it, are some small pits, known as the *Tomotla* bank. The ore is but little used, as it makes a hard iron. Sample 414 was taken from a small pile of it near an old pit.

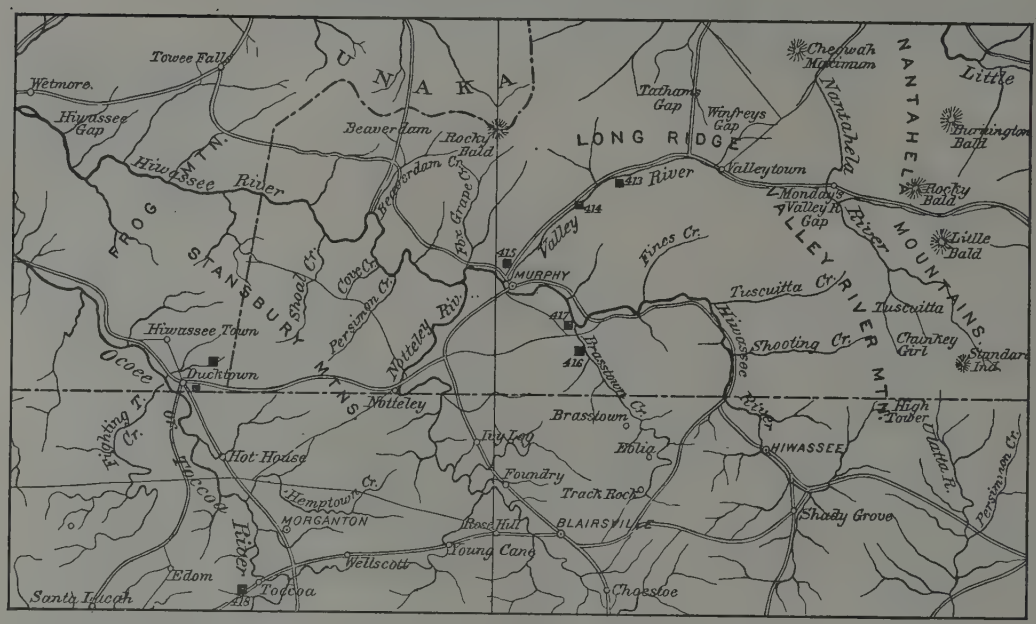
a One-quarter of a mile northeast of Tomotla there are a number of pits, from which good ore is said to be obtained. None of it was to be seen. The extent of the openings indicate that the bed is 200 feet wide at this point, if not more. The analysis of the Tomotla ore gives—

	414.
	Per cent.
Iron	55.85
Phosphorus	0.291
Phosphorus in 100 parts iron	0.521

b

c

d



NOTE.—Mine symbols on this map should have been the half-black circle, to indicate limonite.

FIG. 133.—MAP OF PORTIONS OF CHEROKEE COUNTY, NORTH CAROLINA, AND FANNIN COUNTY, GEORGIA, SHOWING LOCATION OF IRON MINES SAMPLED.

Another point on this range, 1 mile north of Murphy, which has been largely worked, is known as *Section Six*. The diggings are extensive, but so much caved in that but one small exposure of ore was to be seen.

e Sample 415 was taken from this ore in the pit. The analysis gives—

	415.
	Per cent.
Iron	58.25
Phosphorus	0.387
Sulphur	0.160
Phosphorus in 100 parts iron	0.664

The middle belt of ore has not been largely worked near Murphy.

f A small opening 5 miles southeast of Murphy, on the land of *Mr. Little*, furnished sample 417, of which the analysis gives—

	417.
	Per cent.
Iron	51.94
Phosphorus	0.994
Phosphorus in 100 parts iron	1.914

The third or most eastern belt has been quite largely worked at *Mr. Monteith's*, 6 miles southeast of Murphy. The ore is similar to that seen on the first range, and like that is variable in its quality. The better portions of the ore are hard and flint-like, the softer being more silicious, and grading into a brown clay.

The bed at Monteith's varies from 4 to 10 feet in thickness.

Sample 416 was taken from the ore in place, in one of the open cuts. The analysis gives—

	416.
	Per cent.
Iron	56.46
Phosphorus	0.601
Phosphorus in 100 parts iron	1.224

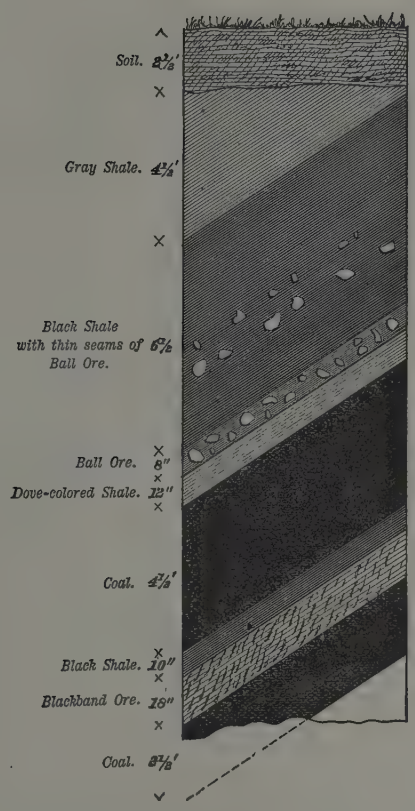
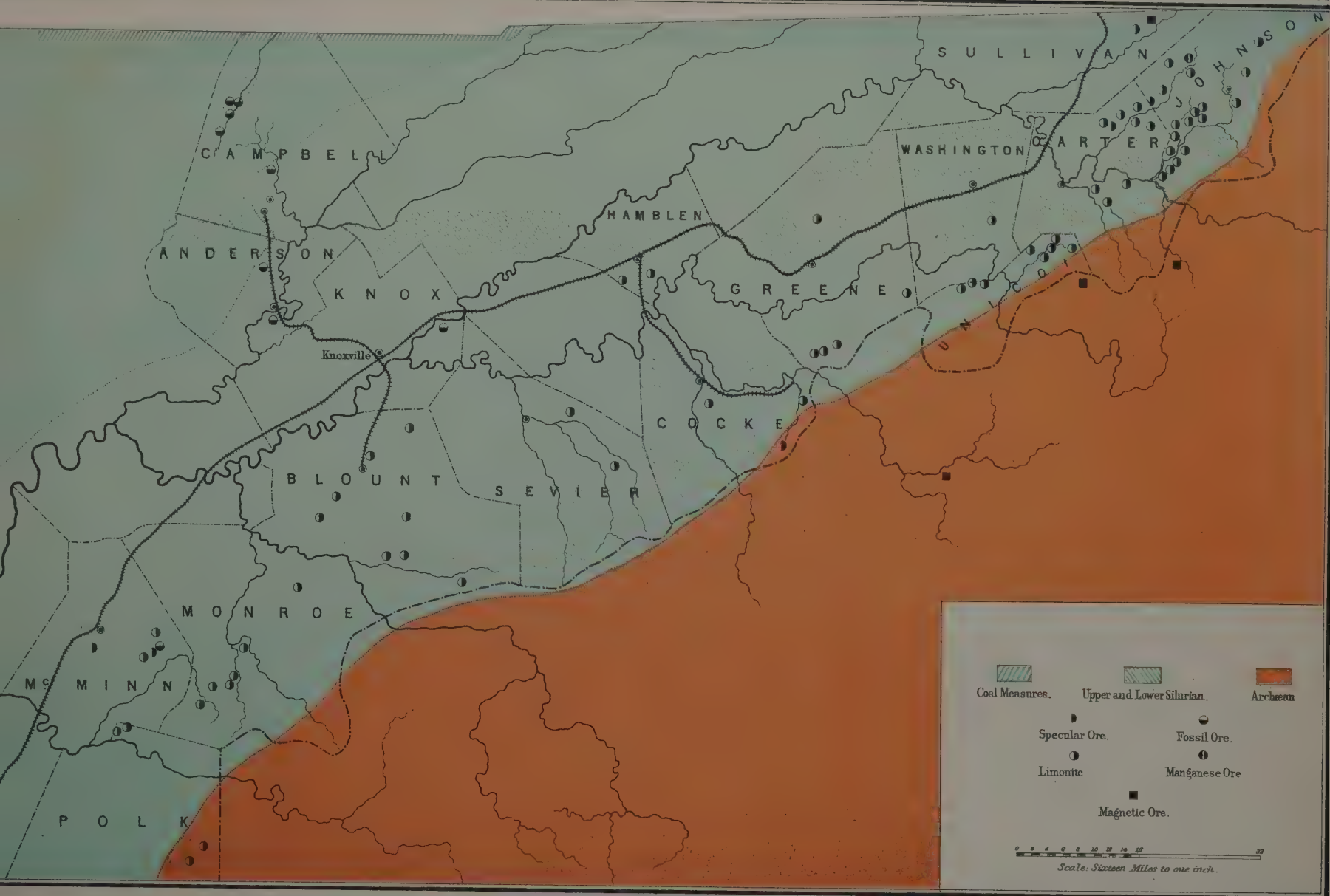


FIG. 112.—SECTION OF COAL-BEDS AT THE GULF. (See p. 306.)



IRON ORE SAMPLE MAP OF PARTS OF EAST TENNESSEE AND NORTH CAROLINA.

Julius Bien Co. Lith.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN EAST TENNESSEE.

By Bailey Willis.

The following report contains a statement of the position of eighty-three different deposits of iron ore in fourteen counties of the valley of East Tennessee and the slopes of the Unaka chain; it does not include the deposits in Bradley, James, Hamilton, Meigs, Rhea, and Roane counties, the description of which is given in the report of Mr. William M. Chauvenet.

Ninety-two samples were taken from these eighty-three localities; they represent—

Limonites	72
Specular ores	6
Magnetite (Sharp's bank)	1
Dyestone ores	8
Manganese ores	5
Total	92

c

The limonites, specular, magnetic, and manganese ores all lie in a belt between the Unaka mountains and the East Tennessee, Virginia, and Georgia railroad, extending from Georgia to Virginia. The dyestone ores are in the continuation of the ranges that enter the state from Alabama and extend northward past Chattanooga; these samples represent but a small part of the range—that lying northwest of Knoxville.

The different deposits are located on the accompanying map (Plate XXXV), which includes the entire field covered by this report. d

Limonites.

The limonites will first be described under the heads of counties, beginning at the south, and the much smaller groups of specular and dyestone ores will be referred to at the end.

POLK COUNTY.

Since the discovery of copper under the limonite outcrops of Ducktown much labor and some money has been uselessly expended searching for the same metal beneath the limonite deposits, so abundant in the Knox group of East Tennessee and Georgia.

In order to afford a basis for partial comparison two samples of the gossan of the *Ducktown* copper mines were selected and analyzed, with the following result: e

	OLD TENNESSEE.	LOUDON.
	479.	480.
	Per cent.	*Per cent.*
Metallic iron	51.94	48.96
Phosphorus	0.030	0.035
Copper	0.56	1.13
Phosphorus ratio	0.058	0.070

f

Sample 479 was taken from gossan thrown out of several shafts recently sunk for black copper ore, which was found at a depth of 15 to 20 feet. These openings were on the school property, 2 miles south of the village Hiwassee.

The other sample, 480, was taken from the gossan removed in sinking the shaft of the *Loudon* mine, where copper was found at a depth of 45 to 50 feet.

The greater percentage of copper would be looked for in the limonite of sample 479, which had been newly mined and lay nearer the copper ore; but the reverse is the case. The per cent. of copper in the gossan is therefore not a criterion for judging the proximity of the ore; and indeed its presence in small amount is no proof of the existence of copper ore below, as copper, zinc, and lead occur in the Knox group limonites. A more reliable proof of the origin of a limonite is to be found in the proportion of phosphorus contained in it. Ores of the Knox group

a derived from an organic sediment, limestone, invariably have a very considerable percentage of phosphorus, while vein-matter of chemical deposition should be expected to contain much less. A third class of limonites of the Tennessee valley, those produced by the decomposition of pyrite segregated in residual clay-beds, contains less phosphorus than the ores of the Knox group; but their occurrence as loose masses in soft clay readily distinguishes them from copper gossan.

In the report on the iron ores of Georgia, the Lower Silurian limonites were traced from where the belt enters the state from Alabama, in Polk county, northward to the Tennessee line. The last deposit described in that report is in Aliculsie valley, in the northeast corner of Murray county. The ore is very silicious, and probably lies in the Chilhowee sandstone, which rises in the long ridge of Star's mountain, in northern Polk county, Tennessee, b and extends across McMinn; then, breaking suddenly down, it reappears in Chilhowee mountain, and continues interruptedly to the Virginia line.

Star's mountain is cut through by Hiwassee river, and 1½ or 2 miles farther north, on the borders of Polk and McMinn counties is a deep gorge, running east and west, known as Gee Creek gap. Two miles up the creek from the western entrance to the gap is a bed of limonite that has been partly stripped, showing a width north and south of 20 to 25 feet; half a mile farther east is another small opening on the continuation of the same bed. Two samples were taken here, 482 from the upper bed, 483 from the lower. The analyses are:

c

	482.	483.
	Per cent.	*Per cent.*
Metallic iron	45.47	49.40
Phosphorus	0.724	1.420
Phosphorus ratio	1.592	2.874

MCMINN COUNTY.

There are two deposits of limonite that have been opened in McMinn county which are less silicious and more porous than those in Polk and Monroe counties. They both lie in Chestnut ridge, 8 miles east of Athens, about 1 mile apart. One is on the land of Mr. R. G. Patty, near the road to White Cliff springs. Pieces of limonite may be seen scattered over the ridge by the roadside, and in a field back of Mr. Patty's barn considerable ore was thrown d out of a pit many years ago. Sample 974 represents this ore.

Mr. Charles Cates, living about 1 mile southwest, has recently sunk several shafts to a depth of forty odd feet, looking for copper, and was still prosecuting the search in July, 1880. The limonite which has led to this exploration bears a strong resemblance in some respects to a copper gossan. The honeycomb structure indicates, in the absence of little concretionary pots, that the ore may be derived from a sulphide; but its occurrence in concretions, which contain aggregations of the peculiar club-like crystals of pyrite, found in the ores near Maryville, Blount county, indicate that it is, like them, derived from nodular pyrite, and probably never contained any copper. Surface fragments of similar limonite are found northeast and southwest along Chestnut ridge for several miles. It is all apparently of similar character.

The analyses of samples taken at Mr. Patty's and Mr. Cates, are as follows:

e

	R. G. PATTY'S.	C. CATE'S.
	974.	975.
	Per cent.	*Per cent.*
Metallic iron	56.79	55.87
Phosphorus	0.094	0.032
Sulphur	0.089	0.273
Phosphorus ratio	0.166	0.057

f The *Hills* bank, fossil ore, and the *Stonedye* bank, a hard specular ore, are within a quarter of a mile of these limonite deposits, and another similar specular ore is found 3 miles south of Athens. (See pages 346 and 350 of this report.)

MONROE COUNTY.

Returning to the ores associated with the Chilhowee sandstone, we find them accompanying it in Guide mountain, near Jalapa, and extending southeast and northeast, with the general trend of the strata.

On the eastern slope of a very rugged ridge, part of the property of Mr. *Jerome Griffiths*, 4 miles south of Jalapa, four shafts were sunk many years ago, to depths of 40 to 100 feet, in search of copper. Nothing was found but a very sandy limonite. Half a mile farther south, near the foot of the most abrupt descent from the ridge, on the southwest quarter of section 17 of the first township of the Ocoee purchase, is a small test pit, from which a very different ore has been thrown out. It seems probable that this belongs to one of the overlying shales or dolomites of the Knox group. This supposition is rendered more probable, as there are said to be three parallel

ranges of limonite about one-quarter of a mile apart, near Jalapa, on the property of Mr. *Curds*. But one of these, a which crops out on a high hill 1 mile south of Jalapa, could be sampled. It is of dark color and resinous luster, and contains small fragments of altered shale that still retain their structure.

The analyses of these ores are as follows:

	CURD'S.	GRIFFITH'S.
	484.	485.
	Per cent.	*Per cent.*
Metallic iron	52.74	53.55
Phosphorus	1.090	0.870
Phosphorus ratio	2.067	1.625

b

The ore-banks of the Tellico furnace, which have been extensively worked at intervals for many years, lie near the North Carolina turnpike, about 4 miles east of Jalapa.

The principal deposit is opened in the *Hale* bank. This is a large open cut in the western slope of one of the wooded ridges, now so much caved in that no ore is to be seen in place. It is said to lie in a large, compact body. No work has ever been done below the level of the entrance to the cut and the floor. Beneath the clay washed in upon it is said to be a solid mass of ore.

During the late war about 500 tons of ore were dug here and piled up for roasting. The approach of Federal c troops prevented the firing of the piles and they are still to be seen, having merely settled as the timbers rotted.

Sample 487 was taken from that portion of this pile not overgrown with weeds and bushes. The ore is dark-colored, dense, and quite homogeneous. It contains some small cavities lined with stalactites, and may be considered a type of the better class of Lower Silurian limonites.

The percentages of iron and phosphorus are given for comparison with the analyses of samples 486 and 488. The complete analysis is as follows:

	487.		487.
	Per cent.		*Per cent.*
Sulphur	0.147	Carbon in carbonaceous matter	0.10
Phosphorus	0.445	Hygroscopic water	0.79
Iron, metallic	54.78	Water of composition	10.28
		Total	100.125
Silica	6.78		
Iron, protoxide	0.37	Per cent. of insoluble silicious matter	8.14
Iron, peroxide	77.65		
Alumina	1.17	Silica	6.78
Lime	0.34	Alumina (with trace of oxide of iron)	0.67
Magnesia	0.32	Lime	0.28
Iron, disulphide	0.275	Magnesia	0.23
Potassa	0.41	Potassa	0.27
Soda	0.25	Soda	0.01
Carbonic acid	0.13		
Phosphoric acid	1.260	Total	8.24

d

e

Donnelly's bank lies half a mile south of the Hale bank. It is opened on the summit of a wooded hill, but has never been much worked. Sample 486 was taken from a few pieces of ore found in the old pit.

These two banks are situated, respectively, 2½ and 3 miles south of the furnace, which was on Tellico river, where it debouches from the mountains.

A quarter of a mile from the old furnace site is a small cave, dug in the side of the hill to obtain enough ore to test it. It was never followed farther.

This limonite is totally different from that of the two banks last described. It is a very open honeycomb ore, associated with yellow clay. The analysis shows that it contains as much iron as the sample from Donnelly's f bank, but the phosphorus is double. It is represented by sample 488.

The analyses of these three ores are:

	DONNELLY.	HALE.	TELLICO.
	486.	487.	488.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	45.03	54.78	45.47
Phosphorus	0.870	0.445	1.530
Manganese, protoxide	1.03	.....	.....
Phosphorus ratio	1.932	0.815	3.365

a About 11 miles north of Tellico furnace are two small openings on limonite beds, that were worked many years ago to supply a forge on Ball Play creek. Sample 489 was taken from a bold outcrop of this ore on the land of Mr. Anderson, the old pits being filled up.

The following is the result of the analysis:

b

	BALL PLAY.
	489.
	Per cent.
Metallic iron	46.56
Phosphorus	0.890
Manganese, protoxide	None.
Phosphorus ratio	1.912

BLOUNT COUNTY.

Chilhowee mountain, which extends northeast from the Tennessee river, separates Safford's Ocoee group, on the east, from the beds of the Knox group, on the west. Iron ore is not mentioned by Safford among the useful minerals of the Ocoee group, but it occurs in this county within the area occupied, according to his determination, c by strata of that age.

Abram's creek, rising among the Smoky mountains, flows south and west through *Cade's cove*, 6 miles in length, whence, escaping by a narrow gorge, it descends to Happy valley and runs south to the Tennessee river, which it joins just east of the gap in Chilhowee mountain.

Limonite has been worked in Cade's cove and Happy valley. There is also a bank 3 miles north of the latter, known as the Flat o' the Mountain bank, which has furnished ore for forges on Abram's creek and in Miller's and Tuckaleechee coves.

As it is 7 miles from Little river and 11 from Happy valley by bridle-paths to *Cade's cove*, across a mountain belt, it is not likely that the limonite will ever be extensively worked. It forms a low ridge 3 miles in length, extending in a northeast and southwest direction across the cove. A forge was worked many years ago to supply d the local demand of the farmers, but nothing has been done for twenty years or more. Sample 491 was taken rom a few pieces of ore dug out of the leaves and clay filling an old pit on the land of William Feezelle.

There are two samples from Happy valley; one is from a test-pit half a mile from the old forge-site on *Abram's creek*, but little ore was to be seen. The other is from a new opening on the west side of Happy valley, in which Squire *J. H. Razer*, was prospecting for copper. While it is true that portions of the ore resemble gossan, the inclosure of cherty fragments proves that it belongs to the stratified group. It is represented by sample 490, while 492 is from the test-pit near the old forge.

The *Flat o' the Mountain* bank is a large deposit, judging from the area over which the old pits extend. It is said that the ore was never followed farther than 15 or 20 feet in depth, it being easier to get it near the surface. It was easy to distinguish two kinds of ore in the scattered fragments; the one of a grayish-brown color is essentially e sandstone cemented by limonite; it is worthless as an iron ore. The other is a dark-colored, sometimes black, ore, with brilliant luster; it is represented by sample 493. The relations of these two could not be ascertained.

The following are the analyses of these four samples:

f

	RAZER'S.	CADE'S COVE.	ABRAM'S CREEK.	FLAT O' THE MOUNTAIN.
	490.	491.	492.	493.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	55.48	55.28	50.23	53.85
Phosphorus	0.491	0.938	0.638	1.042
Manganese	.....	.....	.....	0.410
Phosphorus ratio	0.885	1.696	1.270	1.935

The strata of the Knox group, which form Chestnut ridge in McMinn county, extend northeastward to the Virginia line; they occupy a broad belt in Blount county, and there, as in McMinn, the residual clays contain deposits of limonite derived from pyrite. Similar ores are found in Hamblen county in the same belt, and they occur in another area of the same strata in Greene county.

These ores are valuable on account of the low percentage of phosphorus. As it is but five or six years since the deposits now worked in Blount and Hamblen counties have become known, it seems not unlikely that a careful survey of the areas covered by the Knox group would result in the discovery of similar ores in other localities.

These limonites do not occur in large masses; they form nodules a few inches to 2 or 3 feet in diameter, a imbedded in clay, through which they are irregularly distributed. The deposits thus far worked have proved to be of limited extent.

The *Seaton* bank, 8 miles northeast of Maryville, has been exhausted, after yielding from 800 to 1,000 tons of ore and being worked to a depth of 42 feet. In one part of this bank the ore was distributed approximately in the proportion of one load of ore to one of clay removed.

At the *Wilson* bank, 2 miles northeast of Maryville, the ore occurred in the proportion of one load of ore to eight loads of clay; this bank still continues to yield a large amount of ore, after being worked nine months, and does not seem likely to give out soon.

The *Carpenter* bank, 7 miles south of Maryville, was exhausted after being worked a year; sample 498 was taken from some of the last ore dug at this bank. b

A new bank had just been opened in June, 1880, on the land of the Widow *Kerr*, 10 miles southwest of Maryville; this yielded at the rate of one load of ore to every ten of clay, and test-pits indicate that the deposit underlies about 3 acres.

These banks are all opened on low knolls, and as the ores do not crop out they can only be discovered by the small nodules washed into the gullies, which often cut deep in the soft clays.

Samples were taken of the raw ore from each of the above-mentioned banks, pure pyrite, which still forms the central portion of all the nodules over a foot in diameter, not being included.

c

	WIDOW KERR'S.	SEATON.	CARPENTER.	WILSON BANK.	
				Raw ore.	Roasted ore.
	494.	497.	498.	495.	496.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	57.26	57.60	53.20	53.54	63.80
Phosphorus	0.035	0.104	0.059	0.143	0.064
Sulphur	0.347	0.178	0.266	0.184	0.173
Phosphorus ratio	0.061	0.181	0.111	0.269	0.107

Following is the complete analysis of 495: d

	495.		495.
	Per cent.		*Per cent.*
Sulphur	0.184	Phosphoric acid	0.332
Phosphorus	0.143	Carbon in carbonaceous matter	0.06
Iron, metallic	53.54	Hygroscopic water	2.03
		Water of composition	10.91
Silica	5.01	Total	100.032
Iron, protoxide	0.34		
Iron, peroxide	76.10		
Alumina	4.04	Per cent. of insoluble silicious matter	6.70
Manganese, protoxide	Trace.		
Lime	0.02	Silica	5.01
Magnesia	0.21	Alumina	1.52
Zinc, sulphide	0.54	Lime	0.02
Nickel, sulphide	0.10	Magnesia	0.14
Carbonic acid	0.32		
Sulphuric acid	0.02	Total	6.69

e

SEVIER COUNTY.

Two furnaces and several forges were at one time running in this county, the ore being supplied from two f banks.

The old shafts, from which ore for a furnace on the West fork of Little Pigeon river was obtained, may still be recognized in little circular hollows overgrown with brambles, in a wheat-field close to the road between Newport and Seviersville, 6 miles east of the latter place. A single piece of ore, of about 50 pounds weight, was all that could be found; this was carefully broken up, and sample 909 is a fair average of it. Little hollows filled with club-shaped crystals, derived from pyrite, indicate the origin of the limonite, and the writer was informed by one of the old ore-diggers that at a depth of 55 feet they came to water and the ore "turned all yellow, like gold". The field in which these shafts were sunk is now the property of Mr. G. S. Newman.

The other furnace was situated on the Little East fork of Little Pigeon, 13½ miles east of Seviersville among the outliers of the Unaka mountains. It is now a picturesque ruin overgrown with vines. Ore was obtained from

a a bed, which extends half a mile to the southwest, across several spurs of the Bear-Wallow mountain. Both limonite and manganese ore are to be seen in the old trenches; they seem in places to occur in two separate beds, with 20 to 25 feet of sandstone between them. The limonite is associated with pyrite and quartz.

Sample 910 represents the limonite, 911 the manganese:

b

	NEWMAN'S.	LOVES' FURNACE.	
	909.	910.	911.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	58.38	39.86	6.48
Phosphorus	0.060	0.108	0.097
Manganese oxide	.....	13.835	59.73
Phosphorus ratio	0.103	0.271	.....

COCKE COUNTY.

Limonite occurs in Cocke county east of Newport among the strata of the Ocoee group and the Chilhowee sandstones.

A forge was run many years ago on Upper Cosby creek, among the spurs of the Unakas. Some ore is said to c have been obtained in that vicinity, but the greater amount was hauled from a bank on *Mine ridge*, 2 miles from the mouth of Sweetwater creek, 3 miles southeast of Newport. The ore, which is a light-colored, concretionary limonite, crops out on the summit of the ridge, and extends for half a mile or more along it; it is represented by sample 912, taken at the old pits:

	912.
	Per cent.
Metallic iron	51.68
Phosphorus	0.209
Phosphorus ratio	0.404

d The branch railroad connecting Morristown, Tennessee, with Asheville, North Carolina, passes through Newport and Wolf Creek on the French Broad river. Three miles from the latter place in the hills east of Wolf Creek is a large deposit of dark-colored, homogeneous limonite; this is the property of the "Southern States Coal, Iron, and Land Company", and has been opened but never worked. A tunnel has been driven in near the top of the ridge and passed horizontally through 68 feet of ore. About 100 tons were taken out and now remain near the mouth of the tunnel. Sample 913 was taken as an average of this pile:

e

	913.
	Per cent.
Metallic iron	50.03
Phosphorus	0.823
Phosphorus ratio	1.645

A deposit of specular ore, which has been lately discovered in the metamorphic rocks near the head of Wolf creek, will be described at the end of this chapter among the other ores of the kind.

HAMBLEN COUNTY.

There are two ore-banks south of Morristown, near the line of railroad up the French Broad. Lying in the same belt of Knox strata as the deposits near Maryville, these ores are identical with those there found. The two banks worked are the *Vineyard*, 1 mile north, and the *Williams*, 2 miles west of Witt's foundery. At the former the f modules contain little or no pyrite, which is frequently found in the interior of the larger masses from the latter bank. In other respects the two ores are so much alike that there can be no doubt of their having a common origin—they have resulted through the oxidation of concretionary masses of pyrite.

Samples were taken from the ore mined for shipment to the Roane Iron Company's works. The following are the analyses:

	VINEYARD.	WILLIAMS.
	907.	908.
	Per cent.	*Per cent.*
Metallic iron	52.00	53.81
Phosphorus	0.068	0.020
Phosphorus ratio	0.131	0.052

GREENE COUNTY.

The range of Chilhowee sandstone which is found in eastern Cocke county extends northwestward through a Greene into Washington and Unicoi, accompanied throughout by deposits of limonite. These have been worked in five localities in Greene county; three of them for the furnaces at Hayesville, 11 miles south of Greenville; the other two, situated close together on Greene ridge, for a forge on Camp creek and for the Embreeville works, on Nolichucky river.

The former are the *Varner*, *Lamb*, and *Stephens* banks, respectively 2 miles south, 2 miles southeast, and 2½ miles east of the Hayesville furnace. The latter has been much more extensively worked than the others. Sample 917 was taken from a pile laid up for roasting six years ago. It represents a dark-colored, compact limonite, which incloses little cavities lined with binoxide of manganese.

The old workings at the Lamb and the Varner banks were so much caved in that no ore was seen in place. A few pieces were found at the latter, and are represented by sample 915. It is quite probable that this is below the b average, as the ore is associated with sandstone, cemented by limonite, pieces of which were thickly scattered over the dump-heap. At the Lamb bank a ton of dark-colored compact limonite had been left at the foot of the slope on which it was dug. It seems to be less silicious than the ore of the Varner bank, but this may be rather an apparent than a real difference; for specimens of ore seen at the Lamb bank inclose silicious fragments, and only a careful examination of both could determine the proportions of good and of worthless ore.

	VARNER.	LAMB.	STEPHENS.
	915.	916.	917.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	47.57	53.54	48.87
Phosphorus	1.179	1.376	1.031
Manganese			6.52
Phosphorus ratio	2.478	2.570	2.110

c

The *Greene Ridge* banks are about 12 miles east of Greenville, on a high spur of the Unaka chain, south of Horse creek. The South bank is about half-way up the slope; the East bank, over the ridge, nearer the top. Both consist of large open cuts, dug without system wherever the different operators preferred. There is no apparent difference in the two ores as seen in the specimens; both are compact concretionary limonites, varying in color d from light to dark dull brown. About a ton was found at each bank, and samples 918 and 919 were taken from these piles:

	GREENE RIDGE.	
	South Bank.	East Bank.
	918.	919.
	Per cent.	*Per cent.*
Metallic iron	53.88	48.12
Phosphorus	0.099	0.068
Phosphorus ratio	0.184	0.141

e

A limonite derived from pyrite occurs north and west of Greenville. One range extends from Blue Springs northeast to a point 7 miles west of Greenville; another parallel range is said to have been traced 4 or 5 miles, passing near Babb's mill, north of Greenville. These ores have never been worked to any extent, but a few loads were hauled to Camp Creek forge from a point near the public road, 5½ miles north of Greenville. Here the ore lies in small lumps thickly scattered through the yellow clay. It shows the structure of pyrite, and is essentially the same as that now mined near Maryville, in Blount county.

Sample 920, taken from a small pile of this ore, gives the following result on analysis:

f

	920.
	Per cent.
Metallic iron	57.33
Phosphorus	0.089
Phosphorus ratio	0.155

WASHINGTON AND UNICOI COUNTIES.

a Bompass and Greasy coves were formerly parts of Washington and Carter counties, but have now been cut off in the new county of Unicoi. They contain a larger amount of limonite in proportion to their area than any other part of Tennessee except Doe mountain, in Johnson county.

Professor J. P. Lesley made a survey of these coves in 1872, and has published his observations in a "Note on a fine Upthrow Fault at Embreeville Furnace in East Tennessee", among "Occasional Surveys of Iron, Coal, and Oil Districts of the United States". He says:

Bompass cove is an oval valley 3 or 4 miles long by 1½ wide at its widest part, surrounded by mountains about 1,000 feet high, on the inner slopes of which rest terraces or hill spurs of decomposed limestone (Lower Silurian), holding masses of brown hematite iron ore of two varieties, the lower series (and outer or closer up to the mountain wall) being silicious and cold-short, and the upper series being argillaceous and red-short. The cove is nearly encircled by the cold-short deposits, which have been opened in a number of places, and b a good deal mined toward the head of the cove for an old furnace farther south. The red-short hematites are extensively spread out more in the middle of the cove, where they are capped by lead-bearing members of the limestone formation.

Greasy cove is a large and nearly level limestone plain more than 20 miles long by 5 miles wide, similarly surrounded by shale and sandstone hills nearly 1,000 feet high, and backed by the state line range of the Unaka (sub-Silurian) mountains, more than twice as high.

The ore-banks of *Bompass cove*, opened at the time of Professor Lesley's visit, are now caved in, the tramways are washed away and overgrown, and the furnace is falling in ruins. Under these circumstances no attempt was made to visit all of the old pits, which are scattered over the hill slopes and valley; three typical samples were taken. One, from an opening 4½ miles from Embreeville furnace on the west side of the cove, represents the cold-short limonite of the under beds. Another was taken from the "Main bank" of the furnace, about 3 miles from it, on the east side of the cove. Professor Lesley says of this deposit:

c These ores are irregular masses of ochreous clays and loose sands, full of shot and balls and pipes of the hydrated sesquioxide of iron, with coatings of the black oxide of manganese, and traces of the original sulphide of iron, sulphide of lead, and sulphide of zinc, held by the limestone strata before these were dissolved and made cavernous by the drainage waters which have packed the clay-sand ore into all the holes and crevices, caves, and water-courses thus made.

Again he says:

The stripping varies from a foot or two to 20 and 30 feet. The solid ore-ground consisting of from one-half to four-fifths fine ore, the rest balls, with occasional masses of clay, and occasional masses of solid hard limestone rock (left in its original condition, but with all the edges dissolved round) has been dug into to a depth of ten, fifteen, twenty feet and more in places, without reaching bottom.

Professor Lesley's opportunities for observation were far better than those of the writer, who found no ore in place, but the masses of ore now to be seen, partly imbedded in the clay, washed into the old pits, do not agree d with his description. Their outer surfaces are formed of porous limonite, but the interior consists almost wholly of pyrite, and they seem to have been derived from that mineral. Sample 922 was taken as an average of these masses at this "Main bank". A third sample, No. 924, was taken from the limonite that may be seen immediately overlying the compact limestone of the "Lead mine", through which little scales of galena are thickly scattered; the limonite represented by this sample is very much like that of the "Main bank" in general appearance, but the cavities are larger and the walls thin, while in the other the cavities are small and the thick walls are very compact. The following are the analyses:

e

	MAIN BANK.	COLD-SHORT.	LEAD MINE.
	922.	923.	924.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	57.56	49.11	58.59
Phosphorus	0.149	0.715	0.016
Phosphorus ratio	0.259	1.456	0.027

The ore deposits of Greasy cove were worked from 1825 to 1843 for a furnace and forge, which stood on Indian creek, in what is now the northeastern part of Unicoi county. As nothing had been done at any of the banks since that time there was no opportunity for observing the character or the mode of occurrence of the ore; the f principal openings were visited, however, and samples taken from such pieces as could be picked up at the old diggings. "Limonite post-office", near the "Head of the Big Lane", 10 miles south of Johnson City, is a central point, not far from which Dr. Hannum, the present owner of the principal ore-deposits, was building a forge in July, 1880.

A number of openings on a high ridge 1½ mile west of Limonite post-office are known by the name of the *Casper* bank; this is the most western of the deposits; the ore is open and contains many little pots of more compact limonite, a texture preferred in the forges and cold-blast charcoal furnaces; but it shows dark-colored streaks, having a brilliant, resinous luster, considered by old ore-diggers to indicate a cold-short ore. Another range of ore was opened in the "Keener" and "Big" banks, and in three other small diggings within a quarter of

a mile of Dr. Hannum's house; from the Keener to the Big bank is about 1½ mile in a northeasterly direction. a
This range is associated with manganese ore, which here, as in Johnson county, lies west of and parallel to the iron ore.

Three and a half miles east of Limonite post-office are several beautiful springs, which have given their name, *Blue Springs*, to an ore-bank that was opened forty years ago and abandoned soon after, as other ore was found more conveniently situated; the old diggings seem to indicate an extensive deposit, of which but little has been removed; but the *débris* accumulating through so long a period has so covered the ore, that only enough for sample 926 could be found.

A mile and a half farther south is another deposit, from which a few wagon-loads of ore were hauled fifty years ago; as the ore made a cold-short iron it was not long used. This little opening, known as the Dick's bank, has long since been lost in a dense thicket of southern laurel. b

The analyses of the samples representing these ores are given below:

	CASPER.	BLUE SPRINGS.
	925.	926.
	Per cent.	*Per cent.*
Metallic iron	50.31	47.71
Phosphorus	1.300	0.391
Phosphorus ratio	2.584	0.820

c

One other ore-bank was found in Washington county, on the road from Johnson City to Embreeville, 5 miles southeast of Jonesborough. The old pits are extensive, and much ore is said to have been removed and used in the Embreeville furnace; but only a few pieces of very open honeycomb limonite remained scattered over the surface. These are represented by sample 921, of which the following is the analysis:

	HUFFINE'S BANK.
	921.
	Per cent.
Metallic iron	48.60
Phosphorus	0.308
Phosphorus ratio	0.634

d

CARTER AND JOHNSON COUNTIES.

These have long been the principal iron-producing counties of East Tennessee.

Holston mountain, a ridge of Chilhowee sandstone, forms the western boundary of Carter and a portion of e
Johnson. Iron mountain is a similar elevation, which extends from Doe River cove, in Carter county, to the extreme northwestern corner of Johnson, where it joins Holston mountain, and the two continue as one range into Virginia. Between these ranges are the valley of Stony creek, in Carter county, and Shady valley, in Johnson county, formed by the Knox group. They are separated by a northwest-southeast ridge, Cross mountain, which extends from Iron mountain to Holston.

East of Iron mountain, in Johnson county, are the Knox group valleys of Little Doe and Roane creeks, separated by an isolated ridge of Chilhowee sandstone, Doe mountain, 12 miles long.

East of Roane creek the strata of the Knox group are again limited by Chilhowee ranges, which rise to the great mountain range, formed of Ocoee and metamorphic rocks.

The Stony Creek and Shady valleys are skirted by deposits of limonite. Doe mountain is surrounded by f
them, and they extend along the eastern slope of Iron mountain from Doe River cove to Virginia. In notheastern Johnson county they are worked along the eastern Chilhowee belt.

A complete list of the ore-banks worked in these counties during the last hundred years would number considerably over one hundred; but they are generally small surface diggings, worked while the ore was easily obtained, and abandoned when for any reason, no matter how trivial, it was more easily gotten elsewhere. A few years later the old pits are filled with soft clay and overgrown with vegetation, and forgotten by all but the man who worked them.

One of the principal ore-banks on Roane creek had not been worked for a year, as the forge to which it belonged was being rebuilt. The spot from which ore had last been taken was buried under 20 feet of clay, and it

was only with some difficulty that enough ore was found for a sample. The history of the ore-bank, which is now being opened for the new furnace in process of construction by Judge Butler, of Taylorsville, affords another instance of the loss and rediscovery of these banks. Sixty years ago this deposit was worked for a forge for a short time; other ore was found more conveniently situated and this bank was given up. Recently the property came into the hands of Judge Butler, who had information that ore had once been dug upon it; he employed a man to search for it, and the discovery and trial of the ore have led to the erection of a furnace for making car-wheel iron.

Thirty-four samples were taken in these two counties, namely:

Limonites	27
Specular ores	4
Manganese ores	3
Total	34

These ores may be divided according to localities, as follows:

CARTER COUNTY—Doe River cove; Stony creek.

JOHNSON COUNTY—Roane creek; Little Doe creek; Shady valley.

Doe River cove.—Big Doe river flows in a general northwest course from the Unaka mountains to Elizabethton, where it joins the Watauga river. Six miles east of Elizabethton the river comes out of a narrow gorge and flows

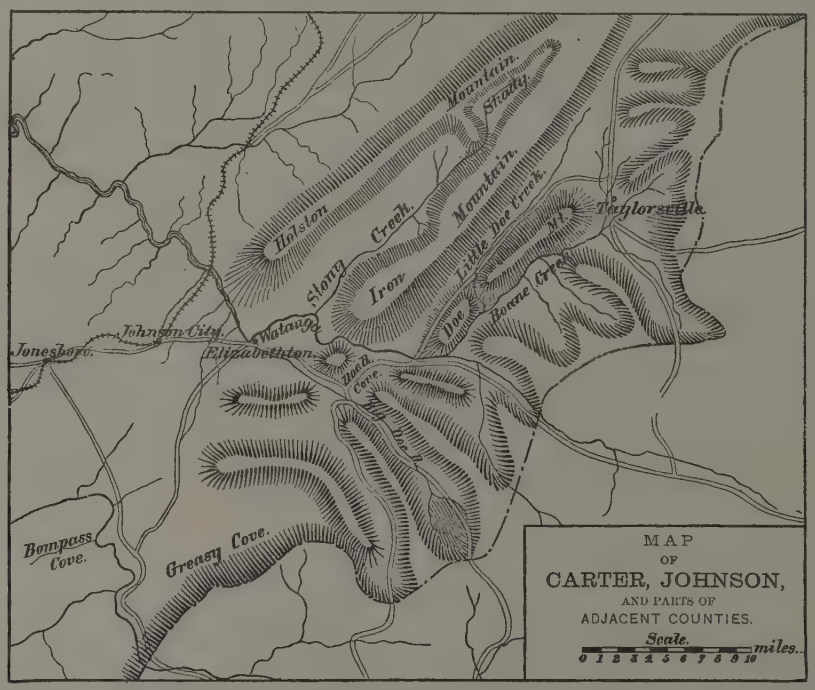


FIG. 134.

for a mile across a level valley, entering on the other side a ravine it has cut through the Chilhowee sandstone of Iron mountain. This valley is formed, according to Safford, by strata of the Knox group, which extend northeastward to Virginia, and surround Doe mountain, the isolated ridge of sandstone already referred to.

In Doe River cove this belt is about a mile wide, with Chilhowee sandstone on both east and west.

Ore banks extend at intervals from Doe river to Watauga river, a distance of 2½ miles along the eastern side, and one has been opened in Iron mountain, west of the cove; it is said these ranges of ore extend to Greasy cove, and are the continuation of those sampled near Limonite post-office.

Cedar Hill bank is on the slope just north of Doe river, on the eastern side of the cove; the *Bear Wallow* bank is another opening on the same deposit, within a hundred yards of the first. No ore could be seen in place, and samples 932 and 933 are from pieces picked up in the old diggings, which are extensive. Sample 932 represents the limonite, which is compact and partly of a light-buff color, with darker streaks. Sample 933 represents a manganese ore found in the old pits with the limonite; here, as at the Keener and Big banks, and also at Carden's, on Watauga river, the manganese ore seems to lie west of the limonite, in a parallel range. This sample was not analyzed.

Sample 931 is from the extensive openings of the *Queen's Station* bank, situated on a steep hill-slope, 4½ miles a east of Elizabethton, north of Doe river. This ore is principally a compact grayish-brown limonite, of homogeneous texture; but some portions of it have a distinctly red streak. In one specimen the mass is limonite, but the shell of a small concretion, inclosed in it, is hematite.

The following are the analyses of these samples:

	QUEEN'S STATION.	CEDAR HILL.
	931.	932.
	Per cent.	*Per cent.*
Metallic iron	57.65	55.92
Phosphorus	0.154	0.576
Phosphorus ratio	0.267	1.030

b

Following is the complete analysis of 931:

	931.		931.
	Per cent.		*Per cent.*
Sulphur	0.139	Phosphoric acid	0.352
Phosphorus	0.154	Carbon in carbonaceous matter	0.10
Iron, metallic	57.65	Hygroscopic water	1.15
		Water of composition	6.60
Silica	4.57	Total	100.038
Iron, protoxide	0.38		
Iron, peroxide	81.81	Per cent. of insoluble silicious matter	6.15
Alumina	3.66		
Manganese, protoxide	0.49	Silica	4.57
Lime	0.32	Alumina	1.22
Magnesia	0.25	Lime	0.32
Iron, disulphide	0.256	Magnesia	0.08
Carbonic acid	0.09		
Sulphuric acid	0.01	Total	6.19

c

d

The farm of Mr. *Wesley Carden* is on the east side of Doe River cove, just south of Watauga river. For over half a mile a range of limonite may be traced northeast and southwest, accompanied, as at Cedar hill and Greasy cove, by a parallel belt of manganese ore. This limonite is very compact and hard, with little cavities lined by quartz crystals. It was formerly worked in a forge on Doe river, but since that was washed away no more ore has been dug.

Sample 934 represents about one ton of ore recently taken from a test-pit southeast of Mr. *Carden's* house, near the summit of a steep ridge. The following is the analysis:

	WESLEY CARDEN'S.
	934.
	Per cent.
Metallic iron	54.03
Phosphorus	0.206
Phosphorus ratio	0.381

e

Little Doe creek.—The road from Elizabethton to Taylorsville, Johnson county, passes through Doe River cove, crosses Watauga river at Dugger's ford, and 6 miles farther north enters the valley of Little Doe creek. This creek flows southwest along the western side of Doe mountain, and turning south at the point where the road f descends to it, cuts through the mountain and enters Roane creek. On the west of this gorge, about a mile from the creek, is the locality known as the "Sinks", a depression surrounded by ridges, on which are five ore-banks, namely, the Wash Place and Hollow bank, 20 steps apart; the Hill and Pine Bark banks, close together, half a mile from the first, and the Stout bank, a half a mile still farther on. These banks are all very similar in the character of their ores, which are open honeycomb limonites, inclosing little pots or hollow concretions. The Hollow bank has received its name on account of the absence of the honeycomb ore and preponderance of the pots. The Pine Bark bank is named from the resemblance of its ore to the scaly bark of the pine. These are all small diggings, and only the *Wash Place* bank was open in July, 1880.

a Sample 935 is from about five tons of ore found piled up at it.

	935.		935.
	Per cent.		*Per cent.*
Sulphur	0.084	Carbonic acid	0.01
Phosphorus	0.214	Sulphuric acid	0.488
Iron, metallic	54.18	Carbon in carbonaceous matter	0.18
Phosphorus ratio	0.395	Hygroscopic water	0.97
		Water of composition	10.46
Silica	5.69	Total	100.061
Iron, protoxide	0.16		
Iron, peroxide	77.08	Per cent. of insoluble silicious matter	6.65
Alumina	2.38		
Manganese, protoxide	0.93	Silica	5.69
Lime	1.16	Alumina	0.71
Magnesia	0.01	Lime	0.26
Iron, disulphide	0.153		
Soda	0.39	Total	6.66

b

Limonites occur on both sides of Little Doe creek; those of the east on Doe mountain; those on the west on the foothills of Iron mountain. It is a generally-accepted opinion among the forgemen that the former are not c cold-short, while the latter invariably are. As a natural consequence the banks on the west are few in number, and those on the east are numerous. Two samples were taken to represent the western range: One from *Rankine's* bank, now worked for Gooden's forge, where sample 936 was obtained; the other from *Stout's* bank, which lies 2 miles northeast of Rankine's, a mile west of the creek; the latter has been but little worked, and the sample represents only what ore could be picked up in the old pit. These ores are both compact and hard, of dark color and resinous luster. The analyses are as follows:

d

	RANKINE'S.	STOUT'S.
	936.	937.
	Per cent.	*Per cent.*
Metallic iron	46.54	50.99
Phosphorus	1.507	1.273
Phosphorus ratio	3.238	2.496

The principal deposits on the western slope of Doe mountain are those of the Sinks and a group which extends along the northern half of the ridge from 7 to 3 miles from Taylorsville; among the latter the *Tompkins*, the *Near* and *Far Mountains*, and the Ground-Hog banks are the most extensively worked.

The latter was not open in July, 1880, but samples of the other three ores were obtained from stock-piles of 1 to 4 tons at Gooden's and Wagener's forges. The result of the analyses are as follows:

e

	TOMPKINS.	FAR MOUNTAIN.	NEAR MOUNTAIN.
	938.	939.	940.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	53.35	54.08	56.26
Phosphorus	0.489	0.255	0.686
Phosphorus ratio	0.917	0.472	1.219

Roane creek.—The northeastern spur of Doe mountain is known as Little mountain; many ore-banks have f been at different times opened on it, and are said to yield an ore like that of the Near and Far Mountain group. Sample 950 was taken from the stock-pile at Brown's forge on Roane creek, 7 miles from Taylorsville; it represents the ore from the *Songa Hollow* bank of Little mountain:

	SONGA HOLLOW.
	950.
	Per cent.
Metallic iron	53.78
Phosphorus	0.441
Phosphorus ratio	0.820

Ten miles south of Taylorsville a little stream, called Mill branch, enters Roane creek from the east. Three-quarters of a mile above the mouth of this branch is Dougherty's furnace, which is supplied with ore from the *Mast* bank, a quarter of a mile south of it; sample 951 represents this limonite, which is compact, homogeneous, and light-colored. a

	MAST.
	951.
	Per cent.
Metallic iron	54.48
Phosphorus	0.768
Phosphorus ratio	1.410

b

A low ridge extends from about 7 miles south of Taylorsville, in a southerly direction, east of Roane creek, to Watauga river. The Mast bank is opened on this ridge. Four miles farther south is another, called the *Baker* bank. Still a mile farther on are two, the John Dugger and the *Cove* banks. The latter lies 300 yards west of the former, and the ore is much like that of Carden's bank, and is similarly associated with manganese ore. It is possible this bank is on the northern end of the range of deposits which extends from Greasy cove, in Unicoi county, through Doe River cove.

The John Dugger bank is said to produce ore similar to that of the Baker bank, which is a very open honeycomb ore, with stalactitic limonite lining the interior of many of the little pots. These banks are worked for Dugger's forge, on Watauga river, 4 miles above the mouth of Roane creek; two others, the *Taylor* and Road Hollow, are c opened in the southern end of this ridge, near the forge. These produce honeycomb ores similar to that of the Baker bank. Dugger's forge had, unfortunately, not been running for over a year, so that the ores were not well exposed. Three samples were obtained, however, representing the ores of the Baker, Cove, and Taylor banks. The analyses are as follows:

	BAKER'S.	COVE.	TAYLOR'S.
	952.	953.	954.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	57.68	46.80	52.83
Phosphorus	0.160	0.606	0.256
Phosphorus ratio	0.278	1.295	0.485

d

Following is the complete analysis of 952:

	952.		952.
	Per cent.		*Per cent.*
Silica	3.80	Carbon in carbonaceous matter	0.11
Iron, protoxide	0.27	Hygroscopic water	0.36
Iron, peroxide	81.94	Water of composition	10.50
Alumina	1.18	Total	99.951
Manganese, protoxide	0.76		
Lime	0.08	Per cent. of insoluble silicious matter	4.46
Magnesia	0.22		
Iron, disulphide	0.214	Silica	3.80
Cobalt, sulphide	Trace.	Alumina	0.65
Copper, sulphide	Trace.	Magnesia	0.05
Carbonic acid	0.14		
Sulphuric acid	0.01	Total	4.50
Phosphoric acid	0.367		

e

Shawn's Cross-roads is on Roane creek, 2 miles south of Taylorsville. Gentry's mountain rises north of it, f on the summit of which is *Donnelly's* bank. This is worked for Rhea's forge, and produces an ore very similar to those just described. It is represented by sample 949, of which the following is the analysis:

	DONNELLY'S.
	949.
	Per cent.
Metallic iron	53.18
Phosphorus	0.291
Phosphorus ratio	0.547

a The ore bank belonging to *Butler's* furnace has already been mentioned. It lies 2½ miles northeast of Taylorsville, the ore cropping out in large masses on the summit of a very steep, high ridge. It consists of dark-colored resinous limonite, which incloses many small fragments of lighter color, apparently the remains of a shale from which the ore is derived. It is represented by sample 947, taken at the bank from ore recently blasted out:

b

	BUTLER'S.
	947.
	Per cent.
Metallic iron	50.74
Phosphorus	1.245
Phosphorus ratio	2.454

Five miles northeast of Taylorsville, in the extreme northeastern corner of Johnson county, on *Laurel fork*, there are several very extensive ore-banks that have long been worked for Colonel Slimp's forge. They were not in operation when visited by the writer, who saw no ore in place. Sample 948 was taken from pieces of ore found scattered over the large diggings. It yields the following result on analysis:

c

	LAUREL FORK.
	948.
	Per cent.
Metallic iron	53.05
Phosphorus	0.336
Phosphorus ratio	0.633

This concludes the limonites of eastern Carter and Johnson counties. The eighteen samples analyzed may be considered to represent fairly the general character of these ores.

Shady valley.—As has already been stated, this is a slight depression lying in the angle between the Holston d mountain on the west and Iron mountain on the east, and separated from the valley of Stony creek by Cross mountain on the south. There are two forges in the valley, on the little stream which escapes through a narrow pass around the eastern end of Cross mountain. These are supplied with ore from several banks, of which the two largest are the Armstead Blevins and the King banks. The ore at both of these is partly a dense, hard limonite, of even texture, and dull buff and brown color, partly delicately honeycomb.

At the *King* bank, which lies at the foot of Holston mountain, just north of the road to Bristol, manganese ore is associated with the limonite. *Blevins* bank is farther east, 6 miles west of Taylorsville. Half a mile northwest of the lower forge the *Silver* bank has lately been opened on a deposit of manganese, with a view to shipping the ore. The openings have not yet penetrated to any depth, and there was but little crystalline pyrolusite to be seen. The greater part of the ore taken out is dense amorphous binoxide, possibly massive pyrolusite, possibly psilomelane.

Sample 956, taken from 3 tons at the lower forge, represents the Blevins ore; 957 is from about 2 tons at the e Silver bank; and samples 958 and 959 represent, respectively, the limonite and manganese ore of the King bank. Samples 957 and 959 were not analyzed. The analyses of samples 956 and 958 are—

	BLEVINS.	KING.
	956.	958.
	Per cent.	*Per cent.*
Metallic iron	52.58	56.73
Phosphorus	0.186	0.092
Manganese	1.20	0.92
Phosphorus ratio	0.354	0.162

f *Stony creek.*—The limonite ores of Stony creek are extensively worked by the Knoxville Car-Wheel Company, which has owned the Carter furnace for a number of years, and has lately put up another, the Maxwell. The writer sampled the ores used by this company at the stock-piles of the furnaces, and did not visit the ore-banks, which are located on both sides of the valley, along northeast and southwest lines, about 10 miles long. The principal ores used in the furnaces in July, 1880, were from the Taylor, Hodge, Lips, and Ferguson banks. There were also small stock-piles at the Carter furnace of the Specular and Red Shear bank ores. In addition to these, the writer sampled the ores of the Hurley, Blevins, James Duggers, Maxwell, and Cannon banks, making eleven samples in all.

The *Taylor* bank furnishes a gravel ore, which is obtained by washing. It is a light-brown limonite, which is said to reduce easily, and has long been worked. Occasionally a larger honeycomb piece is found, but the greater part is very fine.

The ore of the *Hodge* bank is very dark-colored limonite, concretionary and stalactitic. It lies on the eastern a side of the valley, 4 miles from the new furnace.

The *Lips* bank contains two qualities of ore—the one a brown limonite, mottled with almost black resinous lines; the other very much like the "ore" of the Ferguson bank, which would more properly be called a highly ferruginous sandstone; the matrix is limonite, but it is thickly set with rounded grains of pure white quartz.

The ore from the *Specular* bank is very peculiar. It is essentially a limonite, but contains many little plates of micaceous specular ore.

The name *Red Shear* bank indicates the character of the ore. It is in great part, if not entirely, derived from pyrite. Massive pyrite occur in the centers of many nodules, and is to be recognized in the club-shaped forms that stud the interior of many cavities. b

The *Hurley* bank has not been worked lately, and has washed so that only enough ore was found on the surface to give a sample. It is a porous limonite, not unlike that of the Hodge bank.

The *Blevins* and the *James Duggers* banks are only recently opened and have not been worked. Duggers is the blackest limonite seen by the writer, and has the most brilliant resinous luster throughout; it is compact, and some pieces look like pitch. Blevins ore is of much lighter color, and resembles the better quality of ore in the Lips bank.

The Maxwell and the Cannon banks yield specular ores, and their description will be found under that head.

The following are the analyses of the above-described ores:

	DUGGERS.	HURLEY.	BLEVINS.	MAXWELL.	LIPS.	HODGE.	TAYLOR.	FERGUSON.	SPECULAR.	RED SHEAR.	CANNON. c
	962.	963.	964.	965.	966.	967.	968.	969.	970.	971.	972.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	52.24	53.95	49.88	59.19	50.09	34.28	49.73	42.97	53.96	55.67	63.84
Phosphorus	1.717	0.153	1.595	0.019	1.025	0.074	0.056	0.280	0.338	0.133	0.022
Phosphorus ratio	3.287	0.284	3.198	0.32	2.046	0.213	0.113	0.652	0.626	0.239	0.034

The following are the complete analyses of samples 967, 968, and 970:

	967.	968.	970.		967.	968.	970. d
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
Silica	3.38	13.68	12.04	Phosphoric acid	0.166	0.129	0.773
Iron, protoxide		0.43	0.87	Carbon in carbonaceous matter	0.04	0.02	0.03
Iron, peroxide	48.95	70.48	76.04	Hygroscopic water	1.14	1.45	0.36
Alumina	2.38	4.55	2.46	Water of composition	7.89	5.70	6.71
Manganese, protoxide	2.72	1.08	0.14	Total	100.177	100.169	99.944
Manganese, dioxide	32.29						
Lime	0.56	1.56	0.23	Per cent. of insoluble silicious matter	3.67	14.80	12.73
Magnesia	0.17	0.48	0.10				
Iron, disulphide	0.041	0.110	0.111	Silica	3.38	13.68	12.04
Nickel, sulphide	0.18			Alumina	0.22	0.91	0.61 e
Cobalt, sulphide	Trace.			Lime	0.20	0.14	
Copper, sulphide	Trace.			Magnesia	0.04	0.08	0.07
Carbonic acid	0.25	0.39	0.06				
Sulphuric acid	0.02	0.02	0.02	Total	3.66	14.81	12.72

SULLIVAN COUNTY.

Two samples were obtained in this county; one from the *Crockett* bank, 7 miles southeast of Bristol, the other from the *Sharp's* bank, a mile farther north.

At the Crockett bank, where 200 tons of limonite lie piled up, it was necessary to approach from windward on account of the sulphur contained in the ore, which was undergoing slow oxidation. This limonite is of the same character as that now mined in Blount and Hamblen counties; like that it is in the form of nodules contained in f red clay. The opening is on a low mound, and but a small portion has been dug over.

The following is the analysis of the sample taken from the stock-pile referred to, not including pure pyrite:

	CROCKETT.
	961.
	Per cent.
Metallic iron	57.63
Phosphorus	0.018
Sulphur	0.196
Phosphorus ratio	0.031

a The ore of the Sharp bank is different from any other seen in East Tennessee. It has the appearance of a very compact micaceous specular ore, and is in part composed of that variety, but the greater portion is magnetite. This ore is said to lie in an irregular vein from a few inches to 7 feet thick; hand-specimens contain little veins of calcite. It is many years since the bank has been worked, and it has been so often visited that every piece of ore left on the surface has been carried off.

Mr. Thomas Cowan, of Holston Valley post-office, pointed out to the writer a steep ascent, called Gray's hill, a mile south of the bank, on the road to Bushong's furnace, where this ore was formerly used. Overloaded teams frequently threw off lumps of ore on this hill, and with Mr. Cowan's aid a sufficient amount for a sample was here dug out of the clay beds on either side of the road. The following is the analysis of this sample; it does not b represent an average of the ore, but it is the best sample that could be obtained under the circumstances:

c

	SHARP'S.		SHARP'S.
	960.		960.
	Per cent.		*Per cent.*
Sulphur	0.163	Sulphuric acid	0.06
Phosphorus	0.038	Phosphoric acid	0.087
Iron, metallic	56.47	Carbon in carbonaceous matter	0.01
		Hygroscopic water	0.38
Silica	6.09	Water of composition	1.06
Iron, protoxide	9.70	Total	100.117
Iron, peroxide	69.72		
Alumina	0.88	Per cent. of insoluble silicious matter	6.47
Manganese, protoxide	0.15		
Lime	4.73	Silica	6.09
Magnesia	2.02	Alumina	0.38
Iron, disulphide	0.260	Magnesia	Trace.
Nickel, sulphide	Trace.		
Carbonic acid	4.97	Total	6.47

d

Specular Ores.

On page 452 of the *Geology of Tennessee* Professor Safford mentions, under the heading "Hard Solid ore", three localities, the Cannon, the Crockett, and the Sharp's banks. The two latter have already been described under Sullivan county; as there stated, the ore of the Crockett bank is a limonite derived from pyrite; that of the Sharp's bank is a magnetic specular ore. The lead of the Sharp's ore passes near the Crockett bank, and surface fragments of each may be found in that neighborhood.

The *Cannon* bank is the only opening of any extent on a very dense, hard specular ore, of steel-blue color; that has been found in several localities from McMinn county to Virginia. It is on the western side of Stony creek, 5 miles above its mouth, in Carter county. No work having been done there for many years, no ore could be seen e in place. Professor Safford says in regard to it: "The ore occurs here in a regular and solid bed. It rests on a thin stratum of conglomerate of pea-like quartz pebbles, while above and below the rocks are sandy slate or shale, all having a gentle dip". The sample of this ore was obtained about a quarter of a mile west of the old diggings in a field where there were numerous surface fragments.

Six miles northeast of the Cannon bank, on the west side of Stony Creek valley, is the test-pit known as the *Maxwell* bank, from which ore entirely like that of the Cannon bank has been dug.

Two miles farther northeast, in the same line of strike as the Cannon and Maxwell banks, similar blue specular ore was obtained on the summit of *Cross mountain.* Enough ore was found on the surface to furnish a sample, the pits appear to have been very shallow, and there is no reason to suppose that the ore has been exhausted.

f In Greene county the writer observed a more silicious, but otherwise similar, ore among the pebbles in the road which leads east from Greenville just after crossing the Nolichucky river, and several miles farther on, on the way to the Greene Ridge ore-banks, his negro guide pointed out an old pit in which a very sandy specular ore had once been dug for Camp Creek forge.

In McMinn county this specular ore was found in two localities, neither of which has ever been worked for the manufacture of iron. The first is the *Stone Dye* bank, so named because the ore has from time to time been used for dyeing purposes. The sample was obtained in a little gully on the edge of a field, 7¾ miles east of Athens, on the land of Mr. B. F. Brock. The lead of ore extends northeastward to the property of Mr. Bazzell Thomas and Mr. Robert Cochran. The other locality is 3 miles south of Athens, on the property of Sheriff *William Burke*; the largest pieces of this ore seen by the writer were found here, one fragment found close to a very large spring having

a thickness of 9 inches. The very deep gullies in this vicinity all contain more or less of this ore in little washed pieces. Above the spring referred to, which is on the land rented by Mr. Curtis from Sheriff Burke, are large outcrops of limestone or dolomite.

The following are the analyses of the samples taken from these banks in the order they have been described:

	CANNON.	MAXWELL.	CROSS MOUNTAIN.	McMINN COUNTY.	
				Stone Dye.	Burke's.
	972.	965.	955.	976.	481.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	63.84	59.19	58.15	65.36	62.49
Phosphorus	0.022	0.019	0.015	0.024	0.044
Phosphorus ratio	0.034	0.032	0.026	0.037	0.070

It remains to mention a very different deposit of specular ore, which has recently been discovered near the head of Wolf creek, in Cocke county. It lies among the metamorphic rocks, 7 miles south of the present terminus of the railroad that branches off at Morristown from the East Tennessee, Virginia and Georgia railroad.

Major *W. R. Smith*, of Newport, has had the bed uncovered on his own property; it strikes northeast and southwest, and dips about 45° southeast; the entire thickness seen was 5 feet; of this 3 feet consists of blue specular ore containing some pink feldspar. In the lower 2 feet the feldspar predominates to such a degree as to render it too lean for an iron ore. Sample 914 represents the upper 3 feet of this ore, taken by chipping across that portion of the bed.

The following is the analysis:

	914.
	Per cent.
Metallic iron	45.68
Phosphorus	0.016
Sulphur	0.399
Phosphorus ratio	0.035

Following is the complete analysis:

	914.		914.
	Per cent.		*Per cent.*
Silica	26.59	Hygroscopic water	0.12
Iron protoxide	0.96	Water of composition	0.61
Iron, peroxide	63.68	Total	100.078
Alumina	5.05		
Lime	0.18	Per cent. of insoluble silicious matter	32.71
Magnesia	0.06		
Iron, disulphide	0.742	Silica	26.59
Potassa	1.80	Alumina	3.97
Soda	0.17	Lime	0.18
Carbonic acid	0.04	Potassa	1.80
Sulphuric acid	0.01	Soda	0.17
Phosphoric acid	0.036		
Carbon in carbonaceous matter	0.03	Total	32.71

DYESTONE ORES.

For the principal facts as to the dyestone or fossil ores of East Tennessee see the report of Mr. William M. Chauvenet. This report includes only the description of the beds seen in Scott, Campbell, and Anderson counties, and of the peculiar deposit known as the Hill bank, in McMinn county. A sample taken from Knox county has been added.

a The following map, copied from a report of J. B. Killibrew on the "Mineral and Agricultural Resources of the portion of Tennessee along the Cincinnati Southern and Knoxville and Ohio railroads", shows the relations of the different beds sampled in Campbell, Scott, and Anderson counties:

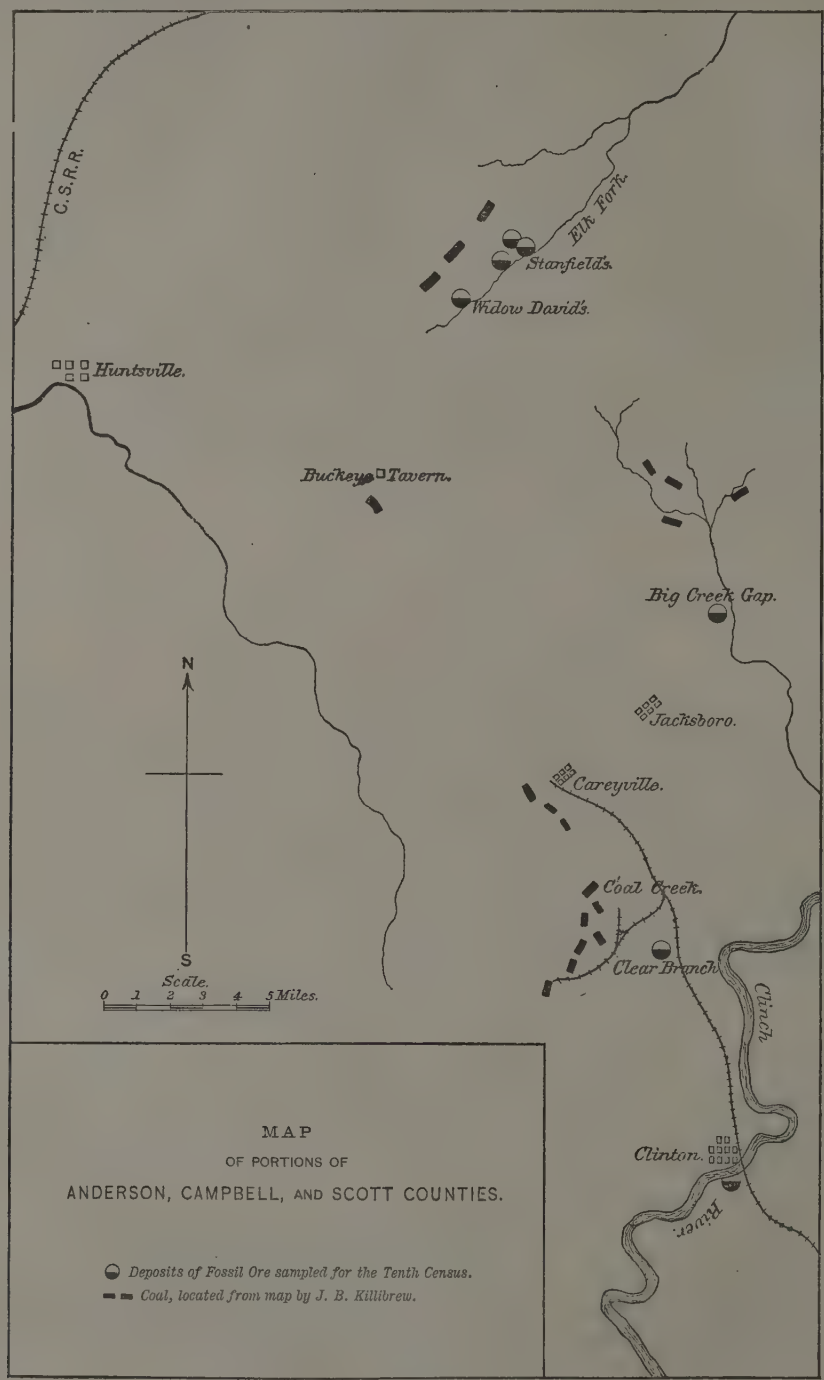


FIG. 135.

The principal range of fossil ore, which lies along the eastern side of Walden's ridge, is interrupted in northern a Anderson county. It has been opened, however, on *Clear branch*, 2½ miles southeast of Coal Creek station of the Knoxville and Ohio railroad, where it has a total thickness of 2½ feet, of which the lower 1 foot is hard ore, the upper 1½ feet is soft ore.

The same ore, lying in a parallel range, has been opened in *Lone mountain*, half a mile from Clinton, on the east side of Clinch river; here it has a thickness of 1 foot, and the bed is separated into two plates by a layer of shale 1 inch thick.

What is probably a continuation of the range seen on Clear branch has been quite extensively worked 8 miles northeast of Caryville, south of *Big Creek* gap. Sharp's forge stood on Big creek; the ore was mined for it along a distance of 300 yards in a straight line to a depth of 10 to 20 feet; it dips 80° toward the northwest, and is said b to have had a uniform thickness of 3 feet.

Samples of ore were obtained from these three deposits from ore in place; the analyses are as follows:

	LONE MOUNTAIN.	BIG CREEK.	CLEAR BRANCH.
	500.	905.	906.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	39.08	41.91	51.90
Phosphorus	0.522	0.559	0.696
Phosphorus ratio	1.336	1.095	1.341

c

It will be noticed that the soft ore from Clear branch, although in the specimen much lighter than the more compact ores from the other localities, is really much richer in iron. This agrees with observations of Mr. Chauvenet elsewhere.

The fossil ores of Elk Fork valley, which lie northwest of Big creek, last described, do not belong to any of the regular ranges; they have been brought to the surface by a great fault, which is described by Professor J. P. Lesley in an unpublished report, quoted in the pamphlet of Mr. Killibrew, already referred to.

The road from Caryville, after passing Morrowville, which is a single house and barn, generally known as "Buckeye tavern", crosses a ridge of Jellico mountain and descends rapidly into Elk Fork valley. At the foot of d the descent is a small area of meadow-land and a house, which formerly belonged to the *widow David*. A short distance beyond the road crosses a little creek, just north of which, 50 feet west of the road, is a terrace, the face of which is a plate of fossil ore. This bed dips about 65° toward the southeast. Another parallel plate, 16 feet below the preceding, forms the face of a portion of the terrace immediately adjacent.

With the aid of Mr. Lewis Stanfield, the writer obtained the following section (Fig. 136) by stripping off the soil which concealed portions of the bed.

Three miles farther north is the property of *Mr. Stanfield*, on which the outcrops of four beds of ore may be seen. It is 160 paces from the outcrop of the upper bed to that of the lowest; the two intermediate ones crop out close together, 40 paces northwest of the uppermost; probably these are the continuation of the widow David's "Big bed", just described. Another outcrop of what is probably the upper plate of the same bed was seen a quarter of e a mile south of Mr. Stanfield's, just where the road makes a sharp descent by a house. The following section (Fig. 137) shows the relations of these ores just north of Mr. Stanfield's:

Samples of these ores were taken at the widow David's big bed, from the upper plate (904); at the outcrop by the steep hill, one-fourth mile south of Stanfield's (902); from the outcrop of the uppermost bed, northeast of Stanfield's (901); and from surface pieces of the lowest bed, west of Stanfield's (903).

The following are the analyses:

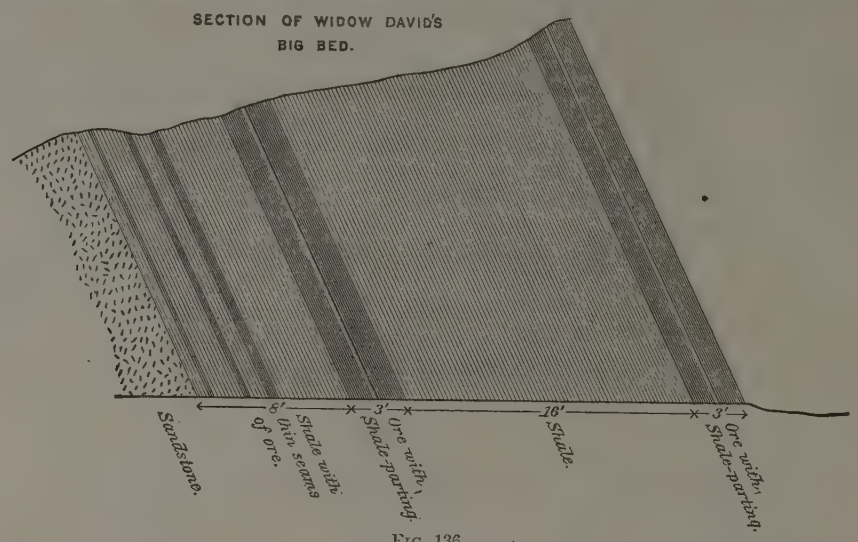
	UPPERMOST BED.	MIDDLE BED.	LOWEST BED.	WIDOW DAVID'S.
	901.	902.	903.	904.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	45.12	41.81	50.13	33.96
Phosphorus	0.729	0.735	0.899	0.395
Phosphorus ratio	1.624	1.757	1.793	1.163

f

In the region 7 to 8 miles east of Athens, in McMinn county, where limonites and dense specular ores occur on Chestnut ridge, close together, is still another peculiar deposit, a dyestone or fossil ore belonging to the Lower Silurian. It does not differ in general character from the typical fossil ore of the Upper Silurian, being composed

like that, partly of oölitic grains, partly of fossils. The principal outcrop is on a low ridge just east of the Federal road, on the property of Mr. Basil Thomas. Surface fragments extend about three-quarters of a mile northeast

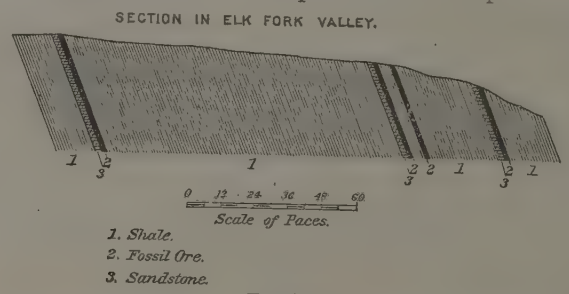
a



b

Fig. 136.

c and southwest, and a similar bed is said to occur 2 miles northeast of this one. The strata appear to dip 30° to 40° to the southeast. It was stated that the ore had been penetrated to a depth of 40 feet.



d

Fig. 137.

The bank is known as the *Hill* bank. The following is the analysis of the sample taken from the outcrop:

e

	HILL'S.
	973.
	Per cent.
Metallic iron	51.42
Phosphorus	0.822
Phosphorus ratio	1.599

One of the eastern outliers of the dyestone ores has been opened and worked about 8½ miles northeast of Knoxville, Knox county, near the road to Strawberry Plains. A furnace erected here just before the war has never been put in blast.

Sample 499 was taken from a small opening from which ore, shipped for trial, had been dug. The thickness f of the bed could not be definitely measured, but it is not less than 5 feet.

	PETERS AND MOWRY.
	499.
	Per cent.
Metallic iron	49.89
Phosphorus	1.652
Phosphorus ratio	3.311

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN TENNESSEE.

By W. M. Chauvenet.

The ores described in this report include those of James, Bradley, Hamilton, Meigs, Rhea, and Roane counties, in eastern Tennessee, and the deposits of limonite throughout the western region.

A description of the ores of the eastern iron region is in the report of Mr. Bailey Willis.

The fossil ores of the Eastern Tennessee valley occur in the Clinton group of the Upper Silurian, and belong to the great Dyestone range, of which those found along Walden's ridge and on the banks of the Tennessee river are a type.

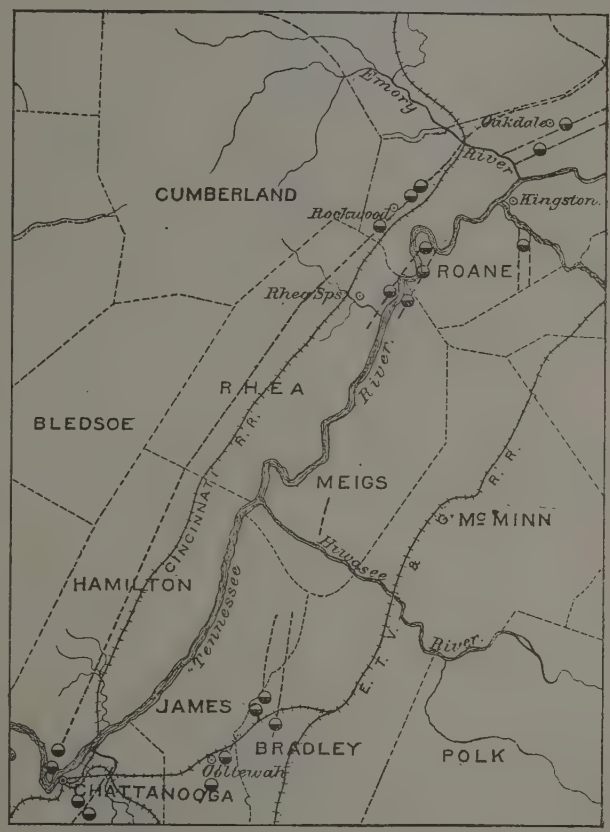
The limonites of the western region occur, according to Dr. J. M. Safford (*Geology of Tennessee*, p. 350, § 911), in the ruins of the silicious group, and are scattered over the whole area included in the western highlands.

The fossil ores of eastern Tennessee occur in a number of distinct ranges, which cover a wide area, and present many complications in geological structure.

The main range, known as the Mountain range, extends along the east flank of Walden's ridge, an outlier of the Cumberland table-land, and can be traced almost continuously throughout the state from Lookout mountain in the south to Cumberland Gap at the Virginia line. The ore-ridges in the Tennessee valley are often duplicated.

The ore from the southern portion of the ranges is similar to that found on the main Alabama range described elsewhere, of which these are but continuations. It shows well-defined fossil forms, and cleaves readily into thin slabs.

Continuing northward, the ore becomes more oölitic in nature, showing in many cases only occasional fossils, or, where the fossils are still thickly scattered, in the place of fossil shells are found impressions of corals and crinoid buttons. The accompanying map (Fig. 139) shows the principal ranges of fossil ore:



VALLEY OF EAST TENNESSEE
SHOWING
RANGES OF FOSSIL ORES.

Openings on the fossil ores.
Ranges.

Fig. 139.

In James county, continuing north into Bradley, east of Ooltewah, the ore has been opened in two parallel ridges, which here trend north and south, known as White Oak mountain and Hinch's ridge.

Fig. 140 shows a section taken at *Ragon's* mine, 3 miles southeast of Ooltewah. A small pit had here been sunk upon the ore, exposing the bed, which here dips southeast at an angle of 30°. The ore is a compact variety, and an average sample taken from the three seams gives, upon analysis:

	273.
	Per cent.
Metallic iron	47.90
Phosphorus	0.128
Phosphorus ratio	0.267

NORTH CAROLINA.
METAMORPHIC.
IRON REGION.
WESTERN
DYKE STONE
SILURIAN
Knoxville.
Clinch River.
Kingston.
Tennessee River.
CHATTANOGA.
FIELD.
COAL
CUMBERLAND TABLE LAND.
L. SILURIAN.
Cumberland River.
NASHVILLE.
Clarksville.
Centreville.
Columbia.
IRON REGION
WESTERN
Tennessee River.
CRETACEOUS.
TERTIARY.
Mississippi River.
MEMPHIS.
M6
S
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
S19
S20
S21
S22
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S34
S35
S36
S37
S38
S39
S40
S41
S42
S43
S44

This opening is on the White Oak Mountain ridge, and a second opening upon the same is found at *Green's* **a** mine on the crown of the ridge south of Ooltewah gap, through which the railroad passes. A peculiar form of fossil ore, known as gravel ore, is here found in the clay above the ore-bed. The individual gravel stones are here scattered through the surface clay, most thickly at a depth of 3 feet, and have all the appearance of water-worn pebbles.

Two samples were here taken, which offer a comparison between this surface-ore and that from the defined bed below. A second sample of the gravel ore was taken from a larger quantity on the stock-pile at South Pittsburgh. The following are the analyses:

	276.	277.	272.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	50.69	59.03	55.30
Phosphorus	0.153	0.056	0.058
Phosphorus ratio	0.302	0.095	0.105

b

No. 276 is from the main bed at the mine. No. 277 is gravel ore sampled at the mine from a pile of 20 tons, taken by breaking the pebbles. No. 272 is gravel ore from the same bed sampled at South Pittsburgh by selecting small unbroken pebbles. **c**

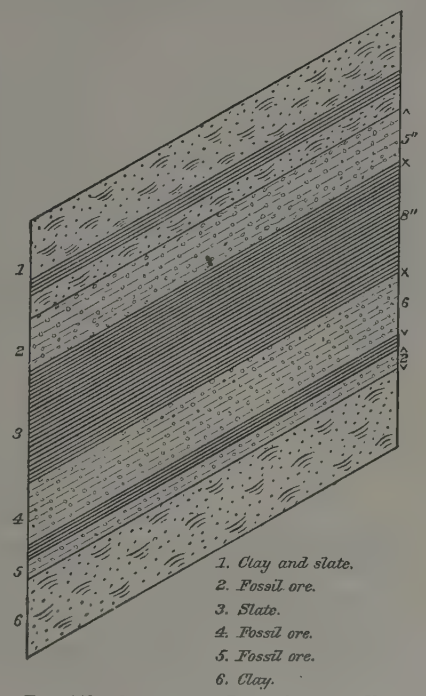


FIG. 140.—SECTION AT RAGON'S MINE, TENNESSEE.

North of Wolf's switch, in Bradley county, the ore has been opened at several points on White Oak mountain and Hinch's ridge. The *Smith* mine, on White Oak mountain, 1¾ miles northwest of Wolf's switch, and *Hinch's* mine, 1 mile from the switch on Hinch's ridge, were the principal working mines. The following are the analyses of the samples taken: **d**

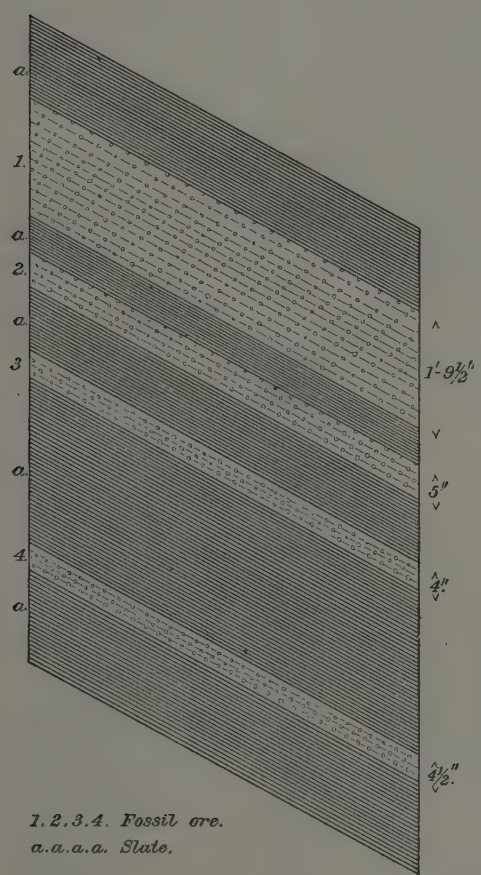


FIG. 141.—SECTION AT THE COKER MINE, TENNESSEE.

	274.	275.
	Per cent.	*Per cent.*
Metallic iron	44.88	54.35
Phosphorus	0.127	0.214
Phosphorus ratio	0.283	0.394

e

No. 274 is from Smith's mine, on White Oak mountain. No. 275 is from Hinch's mine, on Hinch's ridge.

This district is known as the Western Ocoll and Hiwassee district. Many farmers are digging ore in this neighborhood and hauling it in small lots to the various switches along the railroad, where it is sold to ore contractors at different prices. New pits were being opened daily, and no systematic mining was anywhere pursued. The ores sampled were therefore in all cases drawn **f** from near the surface, and were obtained by stripping along the outcrops, no opportunity being anywhere offered for sampling deep upon the beds.

In Hamilton county, opposite Chattanooga, the fossil ore is being mined on a small scale. Fig. 141 shows a section on the property of Clift and Sawyers, where the bed was exposed by a small test-pit sunk upon the outcrop. The ore in these four seams is much decomposed, and crumbles to a fine powder in the hand.

The section shown in Fig. 141 was again exposed 100 feet below on the opposite side of the gulch. Here a tunnel had been run 10 feet upon the outcrop, the ore running quite soft to this depth; beyond this point it is hard and compact, and changes rapidly to a ferruginous limestone, the only soft portion lying near the top of the upper

a bed. Two samples were here taken to illustrate the difference between the hard and the soft ore. The analyses were as follows:

	278.	279.
	Per cent.	*Per cent.*
Metallic iron	31.77	54.76
Phosphorus	0.430	0.753
Phosphorus ratio	1.354	1.375

No. 279 is the soft weathered ore from the exposed face of the outcrop (Fig. 141). No. 278 is the hard calcareous
b ore from the head of the tunnel 10 feet upon the outcrop at the lower opening. The mine is known as *Coker's* mine.

The Dyestone ridges, bearing the bed of fossil ore, are found outcropping both east and west of Lookout mountain, which rests in a synclinal trough. The beds outcropping east of the mountain have been opened in several places from 1 to 3 miles south of Chattanooga. These openings are shallow pits, from 10 to 20 feet deep, extending with the strike. The thickness of the beds, which are here much distorted, varies from 14 to 18 inches. The ore is quite soft and porous, and the seams are but poorly exposed. The analyses of two samples here taken show—

c

	280.	281.
	Per cent.	*Per cent.*
Metallic iron	47.09	48.78
Phosphorus	0.248	0.175
Phosphorus ratio	0.527	0.359

No. 280 is from a small pit 1½ mile south of Chattanooga. No. 281 is from the same lead one-quarter of a mile farther north. The pit is leased by *S. B. Lowe.*

Ascending the Tennessee river, the fossil ore is found on both sides of the stream in Rhea and Meigs counties.

Six miles above Pin Hook landing, and 7 miles northeast of Rhea Springs, in Rhea county, the ore has been largely opened at the *Iron Hill* mine, half a mile from the river. The ore-bed here averages 5 feet in thickness,

d

e

f

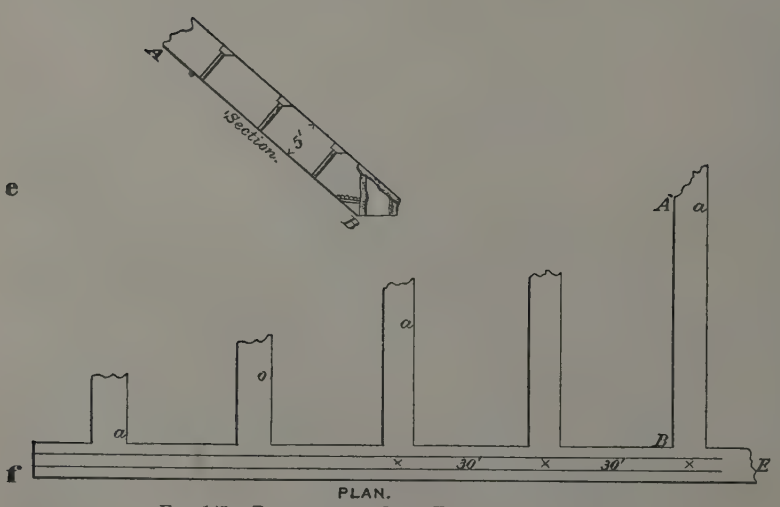


Fig. 142.—Plan of the Iron Hill mine, Tennessee.

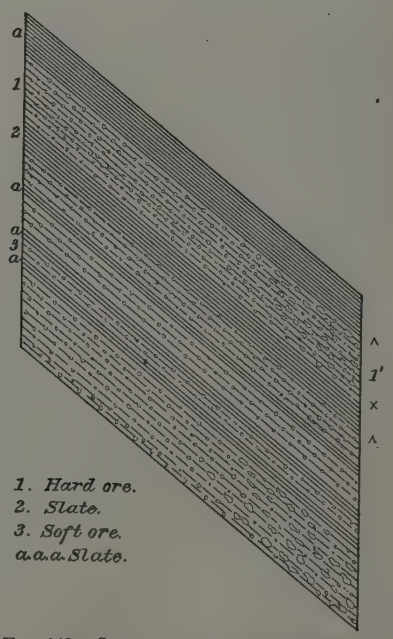


Fig. 143.—Section at end of main entry, Iron Hill mine, Tennessee.

and is opened by an entry run with the strike at water-level, which is here 490 feet below the outcrop, measured on the dip. From this main entry stopes are run at right-angles, at intervals of 30 feet, ascending with the dip of the ore-bed. The bed outcrops on the top of a hillside facing northwest, and dips southeast at an angle of 40°. The ore above water-level, including all of that portion worked, is a soft open-grained variety, distinctly oölitic

in appearance, but showing, also, frequent fossils, cleaving readily into thin slabs, and showing fine spots of a yellow ocher when so cleft. Below water-level the ore becomes much denser, has a much more metallic luster, and no longer cleaves readily into slabs. Hill and Tarwater are the lessees of the mine.

Samples from different parts of the mine are represented in the following analyses:

	293.	294.	295.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	41.77	50.13	51.71
Phosphorus	0.766	0.780	0.506
Phosphorus ratio	1.834	1.556	0.979

b

No. 293 is from the upper 1-foot seam at the top of the main entry near the northeast end, and is the hard ore above mentioned. No. 294 is from the 4-foot seam, taken across the whole end of main entry directly below 293, from which it is separated by a thin slate seam. No. 295 is an average sample of the mine above water-level, taken at different levels on the dip, at *a*, *a*, *a* (Fig. 142).

Fig. 143 shows a section at the end of the main entry marked E (Fig. 142).

Sample 295 shows, upon full analysis, the following results:

c

	295.		295.
	Per cent.		*Per cent.*
Sulphur	0.109	Carbon in carbonaceous matter	0.01
Phosphorus	0.506	Hygroscopic water	0.77
Iron, metallic	51.71	Water of composition	2.94
		Total	99.983
Silica	10.88		
Iron, protoxide	0.69		
Iron, peroxide	72.96	Per cent. of insoluble silicious matter	13.18
Alumina	6.89		
Manganese, protoxide	0.42	Silica	10.88
Lime	2.26	Alumina	1.88
Magnesia	0.73	Lime	0.15
Iron, disulphide	0.205	Magnesia	0.25
Carbonic acid	0.07		
Phosphoric acid	1.158	Total	13.16

d

Directly across the Tennessee river from Iron hill, in Meigs county, the ore has been largely worked at *Kendrick's* mine. The analysis of this ore, from an average sample taken on the stock-piles of the Roane Iron Company, at Chattanooga, is as follows:

	282.
	Per cent.
Metallic iron	51.63
Phosphorus	0.345
Phosphorus ratio	0.668

e

Still ascending the river the ore is found on the south end of Half-Moon island, where it was once dug for old Eagle furnace. These diggings are now abandoned.

At *Brown's* mine, in Roane county, 4 miles above Rockwood landing, on the left bank of the river, the ore-beds are found at two horizons, and are opened by irregular trenches, extending along the outcrops, which are abandoned as soon as the soft surface-ore has been stripped, and a depth of 10 or 15 feet renders timbering necessary. Two samples were here taken, showing, upon analyses—

f

	291.	292.
	Per cent.	*Per cent.*
Metallic iron	52.75	48.65
Phosphorus	0.253	0.072
Phosphorus ratio	0.480	0.148

The ore shown in sample 292 is a flaky, dense ore, showing signs of great pressure in its many smooth, slickenside surfaces, fracturing easily in two directions at right-angles. It comes from the bed highest in the series at this point, and was taken from a small pile of 3 tons. No. 291 is from the main 4-foot bed, and was taken along 50 feet at two points 75 yards apart in the lowest part of the diggings. This sample represents ore from 10 feet upon the bed.

a One mile from the south bank of the Tennessee river, and 5 miles above Kingston, the fossil ore outcrops largely on the southeast faces of the ridges, which here rise prominently. On the property of Mr. B. F. Welcker the ore is exposed in two beds—an upper 4-foot bed of soft ore, showing the effect of weathering, and a second bed, 2½ feet thick, of harder ore, immediately underlying this. Samples were taken from both of these beds at a point about 30 feet from the original outcrop—the beds having been stripped to this depth—and from 3 to 6 feet below the surface of the hill, which here conformed to the lay of the beds. These samples yielded, upon analyses—

b

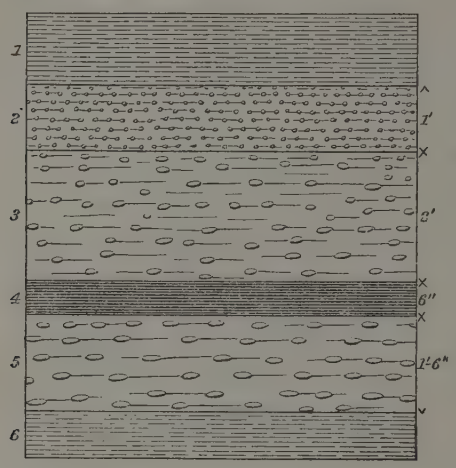
	289.	290.
	Per cent.	*Per cent.*
Metallic iron	44.02	49.26
Phosphorus	0.387	0.426
Phosphorus ratio	0.879	0.865

No. 289 is from the upper bed. No. 290 is from the lower, harder bed. J. D. Roberts is working this mine.

A tram road was in progress from this outcrop to the river, and preparations were being made for shipping the ore to Rockwood furnaces.

The ores mined for the Rockwood furnaces in Roane county are from the mountain-range of fossil ores above described. The ore-beds north and south of the furnaces outcrops in the crown of a number of low hills lying along the east front of Walden's ridge, and forming what is known as Shinbone ridge. The bed, averaging nearly 4 feet in thickness, is highly inclined toward the mountain, and is much faulted and broken.

c



1. *Shale.*
2. *Soft fossil ore.*
3. *Harder fossil ore.*
4. *Slate.*
5. *Hard ore.*
6. *Shale.*

FIG. 144.—SECTION AT PIATT'S MINE, 2½ MILES NORTHEAST OF ROCKWOOD, TENNESSEE.

Two and a half miles northeast of Rockwood the bed lies horizontal for some distance, and is 5 feet in thickness, presenting many irregularities before it regains its upright position, sometimes inclining to the east and sometimes to the west as it continues southward. Fig. 144 shows a section taken at the horizontal portion of the bed.

Continuing southward from this point along the outcrop, the ore has been worked in many places by stripping along the exposed face.

d On *Ivy hill*, one of the Shinbone series, the ore-bed was much contorted, forming "spreads" and folds. The ore presents many varieties, from soft, porous, fossiliferous, to hard, calcareous, and compact, sometimes becoming micaceous and having a greasy feel. In places it has a steely luster and shows slicken-sided, concave plates that fracture at right-angles readily. The ore-bed is overlain by shale and underlain by a thin seam of highly ferruginous limestone, which is in places wanting; beneath this is shale again. Many almond-shaped concretions, both of the underlying limestone and the accompanying shales, are completely incrusted with a bright film of ore of a steely

e luster, and are easily mistaken for ore-lumps until fractured. At many places along the outcrop specimens of limonite are found in close contact with the fossil ore, often forming stalactites and hollow pots. These limonites are never in quantity sufficiently large to render them valuable at the furnaces, and are evidently due to alterations in the fossil red hematite.

The following analyses represent the ores now in use at the furnace:

	287.	288.
	Per cent.	*Per cent.*
Metallic iron	53.30	55.40
Phosphorus	0.920	0.749
Phosphorus ratio	1.726	1.352

No. 287 is from the section shown in Fig. 144, 2½ miles northeast of Rockwood, on Mr. Piatt's land, and comes from the whole face there exposed. No. 288 is from the crown of Ivy hill, on Mr. Piatt's land, 1¾ mile northeast of Rockwood, taken from 50 tons of freshly-mined ore.

In the northern part of Roane county the ore-beds of the mountain range are three or more in number, and spread over an area 2 miles in width. The ores in this vicinity have been opened for Oakdale furnace, which, however, made but a short blast.

On the property of Mr. *Solomon*, 4 miles south of the narrow-gauge railroad to Oakdale, a vertical bed of ore **a** is exposed, from 12 to 15 inches thick. A short trench has here been run along the outcrop. The ore is a soft micaceous variety, giving, upon analysis—

	284.
	Per cent.
Metallic iron	46.34
Phosphorus	1.040
Phosphorus ratio	0.302

Half a mile southeast of the furnace was sunk a **b** shaft 60 feet deep upon the vertical bed of ore, which is here exposed on the hillside near the top of the shaft 15 inches thick. This is known as the "front vein" and contains a soft micaceous variety of fossil ore. The shaft was inaccessible, but a sample was taken from the stock-pile left at the furnace of ore from the greatest depth reached, which was 60 feet, and a second sample from the outcrop at the surface where the ore was being freshly opened. These samples offer **c** another illustration of the difference between the surface ore and that from lower levels upon the bed, giving, upon analysis—

	286.	285.
	Per cent.	*Per cent.*
Metallic iron	37.03	46.34
Phosphorus	0.705	0.140
Phosphorus ratio	1.904	0.302

No. 286 is ore from the bottom of the shaft. No. **d** 285 is from the same bed taken at the surface.

Many farmers are engaged in digging ore from Oakdale, as no systematic development of the beds is attempted.

The accompanying map (Fig. 145) of the western iron region shows the location of the ore-banks visited.

The limonites of this region occur in a well-defined belt, about 50 miles wide, beginning in northern Alabama and extending into Kentucky. The ores **e** occur in clay, associated with more or less decomposed chert in angular fragments, water-worn pebbles, and occasional lumps of coarse sandstone. The defined deposits of ore, known as ore-banks, occur at greater or less intervals over the entire region, though loosely-scattered lumps of surface limonite may be dug from almost every hillside. Throughout the region the ore is mined in open cuts, the masses being followed in the direction promising the best immediate results. At present it is a region of fallen mines and abandoned furnaces, and the samples were in most instances **f** taken from pits deserted twenty years ago.

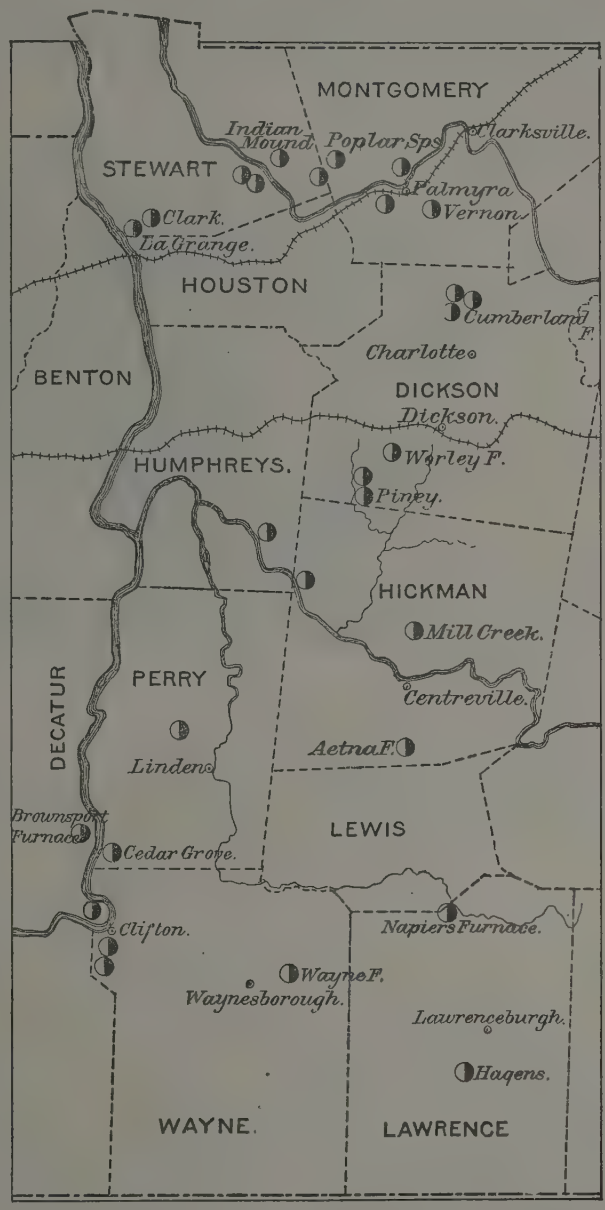


FIG. 145.

Six miles southwest of Lawrenceburg, in Lawrence county, on both sides of the West Point road, the ore was formerly dug for *Hagen's* forge. A sample was taken from such lumps as could be found scattered through the old diggings. The ore is a dense, brittle limonite, showing, upon analysis—

	296.
	Per cent.
Metallic iron	52.43
Phosphorus	0.708
Phosphorus ratio	1.350

a Napier's furnace is situated 7 miles northwest of Henryville, in Lawrence county. Its ore-banks have been recently reopened, and show a rich limonite occurring in pots and honeycombed masses, imbedded in a deep-red clay, which shows fewer chert fragments than usual.

The two main deposits are the *Davis* and the *Pinion* banks, situated 1 mile northwest of the furnace. The Davis bank is a square open cut 50 feet across, yielding principally a porous honeycombed ore of a rich chocolate-brown color, as well as many hollow pots. The Pinion bank, one-quarter mile southwest of this, was worked 50

b

c

d FIG. 146.—POT OF LIMONITE, FROM THE PINION BANK, TENNESSEE.

years ago for a Catalan forge, and is opened by a small circular pit. This bank is remarkable for its many hollow pots and concretionary forms which occur loosely scattered through a deep-red plastic clay. One of these hollow pots is illustrated in Fig. 146. The analysis of these ores show results as follows.

e

	297.	298.	299.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	53.27	49.28	52.61
Phosphorus	0.340	0.543	0.519
Phosphorus ratio	0.638	1.102	0.987

No. 297 is from the Davis bank. No. 298 is from the Pinion bank. No. 299 an average sample from the furnace stock-piles.

Following is the complete analysis of 299:

f

	299.		299.
	Per cent.		*Per cent.*
Sulphur	0.070	Phosphoric acid	1.189
Phosphorus	0.519	Carbon in carbonaceous matter	0.09
Iron, metallic	52.61	Hygroscopic water	0.43
		Water of composition	11.15
Silica	6.19	Total	100.079
Iron, protoxide	0.35		
Iron, peroxide	75.17	Per cent. of insoluble silicious matter	7.59
Alumina	3.57		
Manganese, protoxide	0.92	Silica	6.19
Lime	0.26	Alumina	1.29
Magnesia	0.38	Lime	0.05
Iron, desulphide	0.130	Magnesia	0.11
Carbonic acid	0.25	Total	7.64

Wayne furnace, now out of blast and dismantled, is situated in Wayne county, 5½ miles northeast of Waynesborough, on the Waynesborough pike. The ore-bank is on the crown of the hill back of the furnace, and the old diggings are fallen, covered, and overgrown. A sample was, however, taken from a small tunnel at the northwest end of the north pit from ore in place. This sample shows a dense, cherty ore, yielding, upon analysis—

	300.
	Per cent.
Metallic iron	45.78
Phosphorus	1.084
Phosphorus ratio	2.368

The white and yellow chert associated with the ore seems unusually abundant at this bank.

Two and a half miles south of Clifton, in Wayne county, the limonite ores have been largely worked for the use of Old Marion furnace, now in ruins. The *White* bank, so called to distinguish it from the "Red" bank next to be described, is one-quarter mile northeast of the furnace-site. This bank has not been worked for twenty years, and but little ore was exposed; it lies on the crown and sides of the main ridge, and the old diggings are huge pits from 50 to 100 feet deep and some acres in extent. The sample here taken gives, upon analysis—

	502.
	Per cent.
Metallic iron	50.57
Phosphorus	0.670
Phosphorus ratio	1.325

The *Red* bank, 1½ miles northeast of Marion furnace, near the Waynesborough pike, is a peculiar deposit of limonite. It occurs in sheets and irregular concretions, and has much the appearance of a red hematite, owing to the coating of red oxide on the surface of the lumps. The ore is peculiar to this locality, though a much similar ore is described under the ores of Kentucky at the Old Slate bank, in Bath county. The complete analysis of this ore is as follows:

	501.		501.
	Per cent.		*Per cent.*
Sulphur	0.108	Phosphoric acid	0.719
Phosphorus	0.314	Carbon in carbonaceous matter	0.11
Iron, metallic	54.86	Hygroscopic water	1.51
Phosphorus ratio	0.573	Water of composition	9.17
		Total	100.342
Silica	6.03		
Iron, protoxide	0.92	Per cent. of insoluble silicious matter	7.21
Iron, peroxide	77.21		
Alumina	1.83	Silica	6.03
Manganese, protoxide	0.09	Alumina	1.11
Lime	2.21	Lime	0.10
Magnesia	0.13	Magnesia	0.02
Iron, disulphide	0.203		
Carbonic acid	0.21	Total	7.26

Decatur furnace, now in ruins, is situated on the left bank of the Tennessee river, 6 miles west of Clifton, in Decatur county. Its ore-banks are situated on the crown of the ridge, 2 miles southeast of the furnace-site. The ore is a dense, cherty limonite, associated with broken, angular chert, in yellow surface-clay, and has been irregularly dug over an area covering some acres. A sample was taken from old *détritus-piles*, from such lumps of ore as could be found, and gives upon analysis—

	503.
	Per cent.
Metallic iron	49.79
Phosphorus	1.466
Phosphorus ratio	2.944

Brownsport furnace is situated 3 miles west of the Tennessee river and 7 miles southeast of Decatur, in Decatur county. Its ore-bank is immediately back of the furnace and has been extensively worked. The ore is a dense

a limonite, presenting no peculiarities, much contaminated by the associated chert and the boulders of coarse sandstone thickly scattered through the clay. The bank has been opened by irregular pits upon the hillside back of the furnace. A large cut, 50 feet in depth and as many feet wide, has been run through a natural depression in the hill, exposing only walls of clay thickly scattered with fragments of white chert. The sample taken was from the diggings immediately back of the furnace, and it gives, upon analysis—

b

	504.
	Per cent.
Metallic iron	40.63
Phosphorus	0.366
Phosphorus ratio	0.901

Two miles east of Perryville, in Perry county, the ore was once dug for *Cedar Grove furnace*, now in ruins. A sample, taken from lumps of pot-ore from the old diggings, gives upon analysis—

c

	516.
	Per cent.
Metallic iron	50.88
Phosphorus	0.384
Phosphorus ratio	0.755

One of the most extensive banks of limonite in the region under discussion is the *Ætna* bank, situated between Piney and Brushy forks, tributaries of Beaver Dam creek, in Hickman county. The ore can be traced for 3 miles along the ridges, but has been opened at only one point, at the northwest end of the bank, on the sides and crown of a prominent hill, 1½ mile southeast of the furnace and 7 miles south of Centerville. A large excavation here exposes rugged masses of honeycombed limonite imbedded in yellow clay and associated with angular fragments of chert and sandstone. Besides these irregular ledges, a finer ore is found in loose fragments and hollow concretions scattered throughout the clay. A sample was taken from the old working face at the northwest end of the pit and d from fragments of loosened ore, giving, upon analysis—

	505.
	Per cent.
Metallic iron	50.03
Phosphorus	0.279
Phosphorus ratio	0.558

Ætna furnace is now in ruins and is abandoned.

e Two and a half miles southwest of Graham station, on the Nashville and Tuscaloosa Narrow-Gauge railroad, in Hickman county, is a bank of limonite, formerly worked for *Old Mill Creek furnace*, which was situated 1 mile northeast of the bank. A large excavation has here been made upon the ore-bed, over 50 feet in depth, and covering about 2 acres. The ore is a honeycombed, porous variety of limonite, and occurs in loose masses in yellow clay, which shows less chert than usual in this region. The bottom of the pit was flooded, but a sample was collected from the lump-ore, which seemed still in abundance in the sides of the fallen banks. This sample, taken along the whole circumference of the old pit, gives the following results upon analysis:

f

	506.
	Per cent.
Metallic iron	52.95
Phosphorus	0.303
Phosphorus ratio	0.572

On the west branch of Piney creek, in Dickson county, are situated the ore-banks formerly worked for *Piney furnace*, on the east branch of the same creek. The body of ore, indicated by hundreds of irregular pits and diggings, extends for over a mile along the creek. No system seems to have been followed in the mining of these ores. The pits and their accompanying clay-mounds cover many acres, where the ore nearest the surface and easiest dug has been taken. Like other deposits of the region, the ore is a limonite, associated with chert in red clay. Many rough, sandy masses of ore, thickly scattered with white chert fragments, were found in many places, and had evidently been avoided by the miners.

Two samples were here taken from loose lumps and fragments of broken pots, giving, upon analysis, results as a follows:

	507.	508.
	Per cent.	*Per cent.*
Metallic iron	51.88	51.00
Phosphorus	0.389	0.218
Phosphorus ratio	0.750	0.427

No. 507 is from two pits farthest west, on the land of Mr. W. B. Tatum. No. 508 is from the main bank, 500 yards farther east, on the land of R. D. Manly. These banks have not been worked for many years, but the b quantity of ore that still remains is large.

Worley furnace, situated 5 miles southwest of Dickson, in Dickson county, is running upon ore from two banks upon the furnace property, one known as the "West" bank, the other as the "East" bank. The West bank has not been largely opened, and contains an ore much contaminated by included masses of angular chert. It is a dense limonite, at times concretionary and open, at times dense and cherty, and occurs in irregular patches on the crown of the west ridge. The East bank occupies the crown of the hill rising east of the furnace. Several furnaces were at one time supplied with ore from this bank, and the diggings upon the ore-mass have been very extensive. The surface of the hill is a network of pits and caverns formed by the miners in their irregular methods of work. The occurrence of the ore is uncertain, and the dead-work at times very great, though few of the pits have reached c a depth of over 30 feet. The ore at times is quite free from chert, and is found in hollow pots and other concretionary forms; at other parts of the bank it is a breccia, formed by fragments of white chert firmly bedded in a matrix of dense limonite. The following are analyses of these ores:

	509.	510
	Per cent.	*Per cent.*
Metallic iron	43.31	47.14
Phosphorus	0.434	0.210
Phosphorus ratio	1.002	0.445

d

No. 509 is from the south side of the West bank. No. 510 is an average sample from all parts of the East bank. The old Belleview furnace, 3 miles northeast of Dickson, in Dickson county, drew ore from the Worley bank.

The ore-banks of the *Cumberland furnace* comprise the most extensive deposit of limonite in Dickson county. The furnace is situated 7½ miles northwest of Charlotte. Beginning at the furnace the ore is found along the crown of a prominent ridge, extending for a distance of 4 miles westward, while large deposits are also worked along a range southwest of the furnace to a distance of 4 miles. Besides these, are various other banks of minor importance. Several varieties of ore are found in these different deposits, which will be described in what follows.

The *Bell* bank, occupying the crown and sides of a prominent ridge, 3½ miles southwest of the furnace, has been worked, off and on, for a period of forty years. The ore is a light, very porous limonite, with fine and much contorted lamination, the surface of the layers being covered with bright red and yellow coatings, while their e broken edges are of a dense dark brown. Frequent pebbles of white, partly decomposed chert, surrounded by a denser brown shell, are peculiar to this ore. These pebbles, much resembling broken almonds, are scattered irregularly through the ore-mass in which they are firmly bedded. Occasional masses of a dense brittle ore are also met with in the Bell bank.

The ores of the first-mentioned range nearest the furnace have been worked for sixty or seventy years, and the vast pits and excavations cover an area of many hundred acres in extent. The ore has been mined in some instances to a depth of 70 feet by burrowing and tunneling indiscriminately in every direction. It occurs scattered loosely through red clay in masses often hundreds of tons in weight, though the greater portion of the ore is dug with the pick in the form of small lumps.

The *Nye* bank, half a mile west of the furnace, was the first bank opened for Cumberland furnace, which has f been in blast almost continuously for over seventy years. The body of earth removed has been immense, and the topography of the neighborhood is entirely changed by the excavations and their accompanying dump-piles. The ore in the Nye bank is principally a dense black limonite, fracturing like chert, and occurring in large lumps. Adjoining and directly west of this are two large excavations, known as the *Henry Drake* bank and the *Red* bank. Though in the same hillside, the ore from these two pits is quite different in quality and appearance from that of the Nye bank, resembling that from the Bell bank, above described.

The *Burton* bank is situated 3 miles west of the furnace, and much mining has here been done. The ore is principally a dense, hard limonite, of a dark color and a resinous luster, though varieties of honey-combed ores are occasionally found.

a The following analyses show the nature of these ores:

	511.	512.	513.	514.	515.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	48.08	49.05	55.47	46.50	46.99
Phosphorus	0.213	0.464	0.180	0.341	0.150
Phosphorus ratio	0.443	0.946	0.324	0.733	0.319

No. 511 is an average sample from the furnace stock-pile, representing ores from the Bell, Dry Hollow, and
b Nye banks. No. 512 is from five openings on the Bell bank, of open laminated ore. No. 513 is from the Nye bank, and represents only the dense black ore. No. 514 is from both the Henry Drake and Red banks, and shows only the porous honeycombed ore. No. 515 is from all parts of the Burton bank representing the dense resinous limonite.

It will be seen from the above results that the light, porous varieties, such as that from the Bell bank, contain much more phosphorus than the dark, dense ores represented by samples 513 and 515. The two varieties may be readily separated in mining, and the advantage of such a separation is evident.

Vernon furnace now abandoned, is situated on Bud's creek, 3½ miles southeast of Palmyra. The ore used was drawn from banks a quarter of a mile west of the furnace, in the first ravine entering the valley of the creek from
c that direction. At one point on the south of the ravine the ore was mined in a square pit to a depth of over 50 feet, and good ore found at that depth.

The sample here taken represents ore dug from all parts of the three main pits upon the bank, and gives, upon analysis—

	531.
	Per cent.
Metallic iron	47.06
Phosphorus	0.659
Phosphorus ratio	1.400

d *Steel's* bank, 1 mile southeast of Sailors' Rest station, on the Louisville and Memphis railroad, at one time supplied ore for two furnaces on Yellow creek. A pile of 150 tons from this bank, mined in 1878, was found at the station, which was said to have come from the bottom of a shaft some 50 feet upon the ore-mass. The bulk of the pile was of a dense, hard limonite, though specimens of pipe-ore were found scattered throughout.

The sample taken from the whole pile yields, upon analysis—

	532.
	Per cent.
Metallic iron	52.88
Phosphorus	0.231
Phosphorus ratio	0.437

e

The old Montgomery furnace, 3 miles south of Palmyra, has lately been torn down. It used a pipe limonite from *Bryan's* bank, opposite Palmyra, a quarter of a mile from the Cumberland river, on the Clarksville road. The ore is distinctly columnar in structure, the spaces between the columns being filled with an aluminous red clay, differing in this respect from the yellow clay in which the ore occurs.

The sample was drawn from shoulders and loose lumps of ore exposed in the abandoned diggings, and yields, upon analysis—

	533.
	Per cent.
Metallic iron	56.07
Phosphorus	0.225
Phosphorus ratio	0.401

f

In Montgomery and Stewart counties alone there have been, at different times, as many as twenty blast-furnaces, all running upon limonites from the immediate vicinity.

In some cases, as at Bear Springs, three or four furnaces were supplied from one ore-bank, while others drew their supply from hundreds of small pits scattered over long distances along the ridges, from which the ore was collected by the farmers of the neighborhood. In no single instance was there a systematic mining plant, the ore being dug in irregular open pits, while the dump-piles were allowed to accumulate above valuable deposits of ore deeper upon the bed.

Poplar Springs, 2½ miles south of Oakwood, in Montgomery county, was one of these old furnaces, whose a ore was collected by slave labor from surface-pickings, along the sides of the chert ridges, over a wide area.

An old stock-pile of roasted ore was found at the furnace site, from which a sample was drawn, giving, upon analysis—

	517.
	Per cent.
Metallic iron	34.68
Phosphorus	0.162
Phosphorus ratio	0.467

b

Rough and Ready furnace is situated in Stewart county, 3 miles north of the Cumberland river, and 20 miles directly west of Clarksville. A peculiar variety of pipe limonite was opened 1½ mile northeast of the furnace. This ore owes its origin to the decomposition and alteration of pyrite, unaltered portions of which still form a part of the columns, spreading frequently into bunches of rose-crystals. But the peculiarity of the ore rests in the clear foliated gypsum, which fills the spaces between the columns, giving to the specimens a beautiful appearance.

Were it not for the high per cent. of sulphur necessarily present, this would be a valuable ore, as may be seen from the following analysis:

	518.
	Per cent.
Metallic iron	50.74
Phosphorus	0.156
Phosphorus ratio	0.307

c

This bank was opened just previous to the blowing-out of the furnace, and only a few tons of ore had been taken.

The depth to which some of these limonite deposits extend is well shown at the *Mound* bank, 2¾ miles west of the furnace. A rectangular shaft, 40 by 50 feet, had here been sunk upon the ore-bed to a depth of 105 feet, without reaching the bottom of the deposit. The mouth of this shaft, which is now filled and fallen, was 60 feet above water-level on the crown of a prominent ridge, in the sides of which the ore was exposed by other open pits. It d is a dense, brittle, limonite occurring in concretions and pots, and is compared, in the following analyses, with a pipe-limonite from Indian mound:

	519.	530.
	Per cent.	*Per cent.*
Metallic iron	48.87	55.15
Phosphorus	0.286	0.197
Phosphorus ratio	0.585	0.358

No. 519 is from the Mound bank above described, and represents surface-ore alone. No. 530 was taken from e a small pit on the land of Mr. *E. C. Outlaw*, situated a quarter of a mile southwest of Indian mound, and 3 miles northwest of Rough and Ready furnace, for which the ore was used. No. 530 was further subjected to full analysis, with the following result:

	530.		530.
	Per cent.		*Per cent.*
Sulphur	0.193	Phosphoric acid	0.452
Phosphorus	0.197	Carbon in carbonaceous matter	0.10
Iron, metallic	55.15	Hygroscopic water	0.86
		Water of composition	10.04
Silica	6.65	Total	100.125
Iron, protoxide	0.57		
Iron, peroxide	77.95	Per cent. of insoluble silicious matter	7.51
Alumina	2.69		
Manganese, protoxide	Trace.	Silica	6.65
Lime	0.18	Alumina	0.65
Magnesia	0.17	Lime	0.12
Iron, disulphide	0.333	Magnesia	0.04
Carbonic acid	0.09		
Sulphuric acid	0.04	Total	7.46

f

Bear Springs' furnace, on the property of the Cumberland Iron-Works, is situated on the west bank of the Cumberland river, in Stewart county, 5 miles southeast of Dover. This is an extensive property, comprising, at

a one time, four blast-furnaces—Cumberland, Dover, Bear Springs, and Bellwood—situated at different points, on a tract of land embracing 111 square miles. Bear Springs' furnace is at present in blast, and is situated in the creek bottom between the two main ore-ridges; the others have been long in ruins and are abandoned. The *Bellwood* bank, formerly mined for that furnace, is upon the crown of the ridge, one-quarter of a mile west of Bear Springs. This bank has been worked for many years, and presents a network of irregular pits and tunnels averaging 25 to 30 feet in depth, and, when visited, flooded with water. The western part of the bank is now being opened in a somewhat more systematic manner, by a trench entering the ore-bed lower upon the hillside. The ore is a dark brittle limonite occurring in hollow concretions and rounded pots, lined with a pitchy coating. The high ridge rising east of the furnace contains large deposits of limonite which have been extensively mined over a long period. The b *Race*, *Grave-yard*, and *East Bellwood* banks are names given to three adjoining pits upon the crown of the ridge. The ore is similar to that of the *West Bellwood* bank, the associated clay being here unusually free from fragments of chert, especially at a depth of 20 or 30 feet from the surface. A bank of pipe-ore is to be reopened 3 miles west of the furnace.

The analyses of the ores from these different banks are as follows:

c

	520.	521.	522.	523.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	54.85	50.36	57.55	52.111
Phosphorus	0.235	0.189	0.197	0.129
Phosphorus ratio	0.428	0.375	0.342	0.248

No. 520, from roof and sides of tunnels at the west end of Bellwood bank. No. 521, from north side of the hill at Bellwood bank, "new cut." No. 522, pipe-limonite from a bank 3 miles west of Bear Springs, sampled from ore at the furnace. No. 523 is from the East Bellwood, Race, and Grave-yard banks, taken from 10 to 20 feet upon the ore-beds, from loose lumps.

The furnaces of the La Grange Iron Company are two in number, situated upon Leatherwood creek, which enters the Tennessee river in the extreme south of Stewart county. *Clark furnace* is located 2½ miles from the river. Its ore-banks occupy the slopes and crowns of the prominent ridges on both sides of the creek bottom, here d about one-quarter of a mile in width. The north ridge, known as Clark hill, has been largely worked, and presents a network of irregular pits and burrows, the mass of the deposit lying well upon the crown of the hill. The ore is a limonite, occurring in pots and concretions in red clay.

South of the creek the ore has been opened by a number of smaller pits lying high on the crest of the ridge, which rises precipitously from the stream-bed to a height of 150 feet. Other deposits of value are now being opened at the heads of several ravines entering the valley of Leatherwood creek from the north, 1 mile west of Clark furnace.

La Grange furnace, situated on the south side of the creek, 1 mile from the river, has been lately rebuilt, and is the first and only brick stack ever erected in western Tennessee. Its main ore-banks are the *La Grange* and *Sheridan*, the former situated one-half mile north of the furnace, the latter three-quarters of a mile northwest. e There are extensive and valuable deposits of limonite occupying a low position on the north side of the valley. The ore is a dense, brittle limonite, occurring in hollow concretions scattered loosely throughout the clay, and huge, honeycombed masses, which often degenerate into rough, sandy ledges. Those portions of the deposit near the surface are much contaminated by thickly-scattered fragments of white chert, which are at times included in the ore-mass, giving it the appearance of a breccia. Deeper upon the bed the chert in great measure disappears and the sandy ledges become less frequent, a fact illustrated at several of the banks above described where any depth had been reached. These banks, which had been miserably opened, are now being put in better shape, and test-pits have shown the mass of the ore-deposit to underlie the old diggings.

The following are the analyses of samples from both Clark and La Grange furnace banks:

f

	524.	525.	526.	527.	528.	529.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	49.56	51.34	48.38	50.91	52.22	50.94
Phosphorus	0.257	0.157	0.177	0.237	0.330	0.293
Phosphorus ratio	0.519	0.310	0.366	0.465	0.632	0.575

No. 524 is from the *Davis*, *Peragin*, and *Pierpoint* banks, on Clark hill, and was taken from a mixed stock-pile of 900 tons, at Clark furnace. No. 525 is from the *Fig* and *Bayley* bank, on the south ridge, one-quarter of a mile west of Clark furnace, an average sample from all working-faces. No. 526 is from a small opening on the *Banagan* and *Shurlock* bank, at the head of Dry hollow. No. 527 is a sample from 400 tons at La Grange furnace, representing

an average of La Grange and Sheridan banks. No. 528 is from the La Grange bank, only from 20 to 40 feet below the surface along the whole working-face of the pit. No. 529 is from the Sheridan bank, alone representing an average. No. 527 has been further subjected to complete analysis, with the following results:

	527.		527.
	Per cent.		*Per cent.*
Sulphur	0.069	Phosphoric acid	0.543
Phosphorus	0.237	Carbon in carbonaceous matter	0.10
Iron, metallic	50.91	Hygroscopic water	0.57
		Water of composition	9.45
Silica	12.76	Total	100.119
Iron, protoxide	0.36		
Iron, peroxide	72.28	Per cent. of insoluble silicious matter	13.52
Alumina	2.83		
Manganese, protoxide	0.31	Silica	12.76
Lime	0.42	Alumina	0.58
Magnesia	0.17	Lime	0.13
Iron, disulphide	0.096	Magnesia	0.06
Carbonic acid	0.19		
Sulphuric acid	0.04	Total	13.53

The ores of the Western region just described, though they have been largely worked in certain localities, when considered in relation to their whole extent, have been scarcely touched and but partially located. The shiftless system of mining, which is confined to the portions of the ores nearest the surface, has done but little to define the probable depth of the deposits, while the surface accumulations of chert have in many instances made the banks appear of less value than they may prove to be when opened systematically. The value of the surface deposits is largely dependent upon the chert, and they become valuable or worthless as this is more or less persistent.

The continuation of the region in Kentucky will be found under the ores of that state.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN GEORGIA.

By Bailey Willis.

The iron ores of Georgia sampled for the Tenth census are nearly all limonites; the only exceptions are the dyestone ores of the extreme northwestern counties and a single deposit of specular ore near Cartersville, in Bartow county.

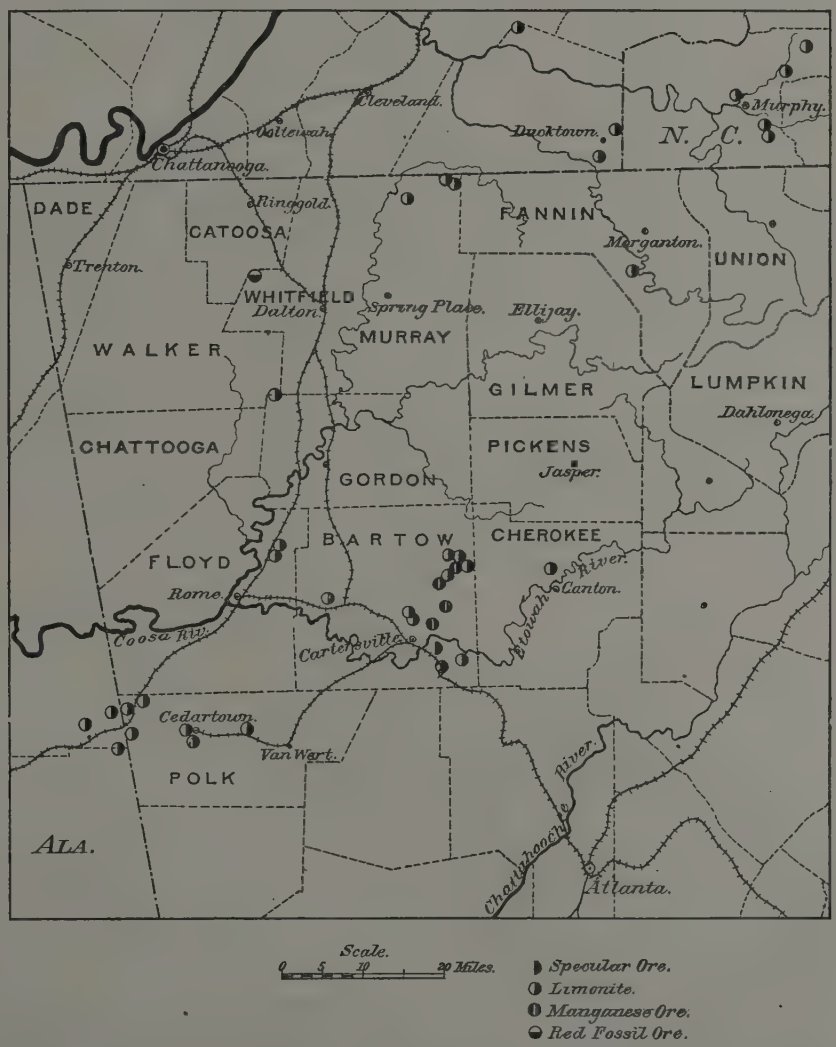


Fig. 147.—Iron Ore Sample Map of Northwestern Georgia and parts of Alabama, Tennessee, and North Carolina.

In addition to the iron ores the manganese banks of the "Pyrolusite Mining Company", near Cartersville, were visited and sampled. (See the following chapter).

a The limonites of Georgia appear to belong to two different geological horizons. The three beds of Cherokee county, North Carolina, extend into Union, Fannin, and Gilmer (?) counties, and are there associated with the marble and steatite beds, assigned by Professor Kerr to the Huronian. The limonites of Polk county, in the western part of the state, are in the continuation of the range worked in Cherokee county, Alabama; this range is placed by Professor Smith in the Silurian.

According to Professor Little, in the *Handbook of Georgia*, 1876, page 47, the numerous deposits of ore near Cartersville are contained in Safford's Knox group and Chilhowee sandstone (?), which would agree with Professor Smith.

As there is no published report in which the areas of the Huronian (?) and Lower Silurian are defined, and no b work could be done to determine their limits, they are not mapped on the accompanying sketch (Fig. 147).

FANNIN COUNTY.—Five miles south of Morganton, near the road to Cartersville, is a deposit of limonite which has been largely worked to supply Hempton Creek forge; the opening is known as *Jarrett's* bank. This bank was not visited, but the ore is said to lie in a bed 10 to 25 feet thick, associated with a range of marble and other beds that would identify it with the limonites of Cherokee county, North Carolina. Samples 418, 419, and 420 represent this ore as brought to Hempton Creek forge; 418 is from about a ton of the raw ore; 419 is from several tons of burnt ore; and 420 is from a few shovelsful of ore that had been burnt, stamped, and washed, and was ready for use in the forge. The analyses give—

c

	418.	419.	420.
	Per cent.	*Per cent.*	*Per cent.*
Iron	53.41	57.83	57.40
Phosphorus	0.284	0.265	0.331
Phosphorus in 100 parts iron	0.532	0.458	0.577

Sample 420 is lower in iron than 419, although it has been washed as well as burned. This is explained by the fact that 420 was dug several days before 419, and was probably poorer when it started on its round of changes. It is one proof of the variable character of these ores. This range is said to continue on to Ellijay and beyond, accompanied by its characteristic associations. Large limonite outcrops are said to occur near Jasper, in Pickens d county; but it may be questioned whether they do not belong to the same horizon as those near Cartersville.

An ore, which would seem by the silicious character of some portions of it to be related to the latter, is found on Judge *Donaldson's* land 3 miles northwest of Canton, in Cherokee county. It lies in concretionary masses, accompanied by a bluish earth, which is sometimes sandy and has a deep-red streak; this earth is slightly magnetic, as is also in a less degree the limonite, and yields on washing the martite (?), which is numbered *a*422, and is represented by that analysis. The width of this bed is about 50 feet, and it has been opened at several places for the supply of a furnace which was begun during the late war, but never finished.

Sample 421 represents the limonite, and 422 the bluish magnetic earth; these were taken at the bank. Sample *a*422 was obtained from 422 by washing in the laboratory. The analyses give—

e

	421.	422.	*a*422.
	Per cent.	*Per cent.*	*Per cent.*
Iron	52.70	48.47	67.81
Phosphorus	0.66	0.139	0.039
Phosphorus in 100 parts iron	1.252	0.287	0.057

BARTOW COUNTY.—Professor Little, in the *Handbook of Georgia* for 1876, page 47, states that the Etowah river cuts through the following section in crossing Bartow county from east to west. Beginning at Stamp creek, it traverses (1) Safford's Ocoee conglomerate (Acadian), (2) Safford's Chilhowee sandstone (Potsdam), (3) Safford's Knox sandstone (Calciferous), (4) Safford's Knox dolomite (Quebec), (5) the Maclurea limestone, and (6) the Trenton. f The second and third of these formations lie in the eastern part of the county, and appear to form the strata in which are contained the very numerous deposits of limonite and manganese that extend from the Bartow furnace, 4 miles south of Cartersville, to Wolf Pen, 9 miles north of the same place, with but slight breaks.

The following map (Fig. 148) shows the location of the principal ore-banks. There are many other small openings, but every variety of the ores is represented in the samples taken:

Bartow furnace is situated on the line of the Western and Atlantic railroad, 4½ miles southeast of Cartersville. There are four ore-banks near the furnace, one of them within a hundred yards of it, the farthest a quarter of a mile off to the southwest. The two most western of the four are on a range of hills, about 100 feet above the valley; the ore in these is concretionary, and occurs in large nodules and irregular pockets. The other two banks are formed of pebbles and large lumps of ore imbedded in a red clay, apparently derived from the range west of

them. The largest of these banks is that which lies about one-quarter of a mile southwest of the furnace. The ore-bearing stratum is from 50 to 100 feet thick, and consists of a sandy-clay in which are imbedded irregular concretions of limonite. The strike of the range is about north 10° to 20° east, and the dip is 40° to 50° to the southeast.

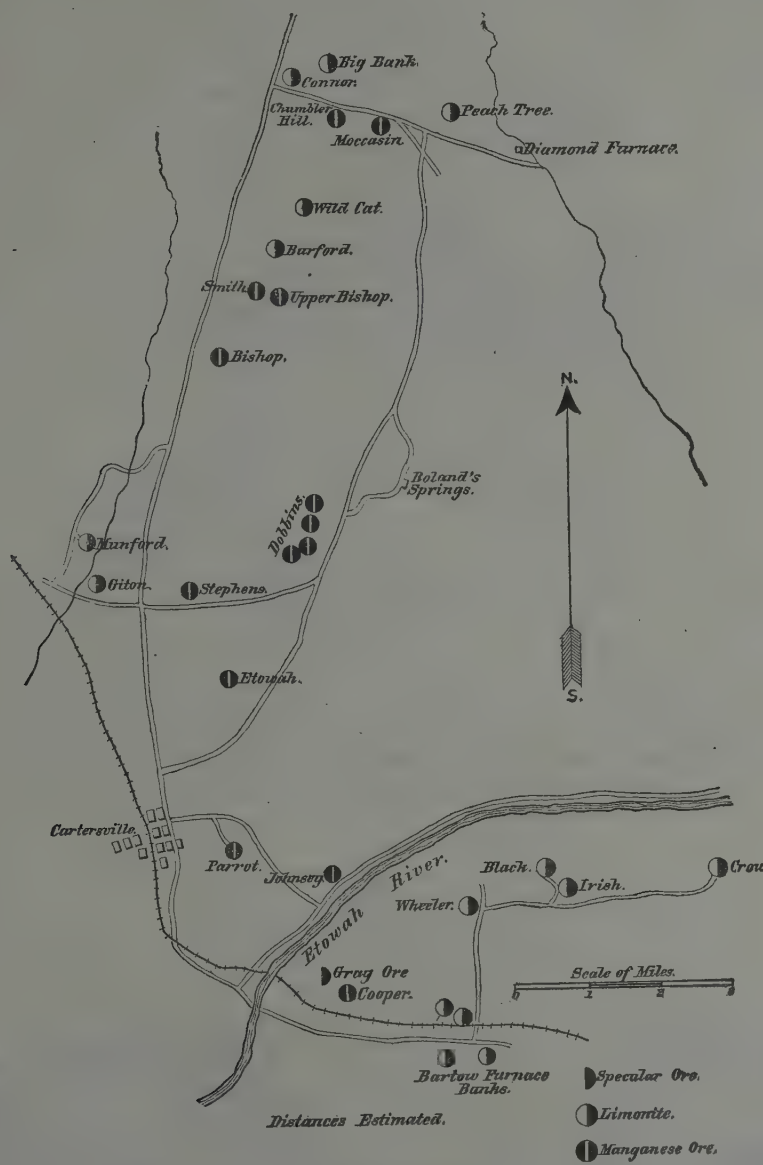


FIG. 148.—SKETCH MAP OF ORE BANKS NEAR CARTERSVILLE, BARTOW COUNTY, GEORGIA.

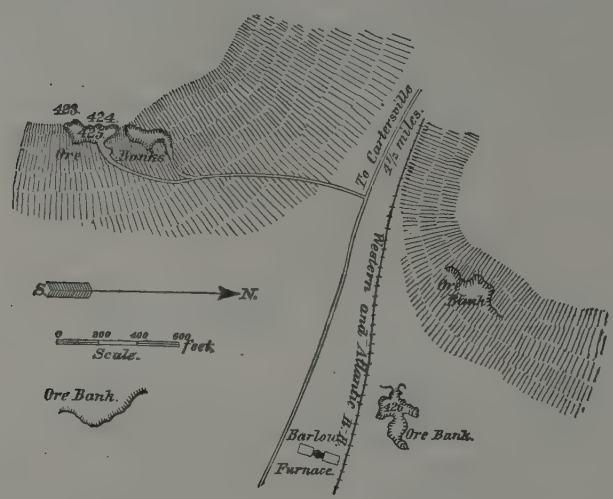
Samples 423, 424, and 425 were taken at this bank from three different qualities of ore. The first was being dug near the southeast corner of the pit; it is a hard limonite, and is considered the richest ore at the bank; the second is from another pocket near by, which is much softer and supposed to contain more manganese. The third is a portion of the matrix in which the ore occurs that has been penetrated by a solution of iron and contains an appreciable amount of it. The following (Figs. 150 and 151) are sketches of two specimens which accompany sample 425 and bear the record of several changes. The cemented fragments of the one and the cavity in the other, which was filled with light-yellow sandy clay, show that a rigid, unyielding rock has been fractured, has decomposed in place without loss of form, and has been subsequently indurated and cemented by deposition of limonite from solution. Where

a the fragment was of some size the iron did not entirely transform it, but left in the center a portion of the original mass, which by further decomposition formed the soft clay found within. The following are the analyses of the three samples taken from this bank:

b

	423.	424.	425.
	Per cent.	*Per cent.*	*Per cent.*
Iron	50.57	53.67	40.35
Phosphorus	1.911	0.488	0.319
Manganese	2.35	5.25	----------
Phosphorus in 100 parts iron	3.779	0.909	0.791

c



d

FIG. 149.—SKETCH OF THE VICINITY OF BARTOW FURNACE, BARTOW COUNTY, GEORGIA.

Sample 426 was taken from a small pile of the pebble-ore found in the bank nearest the furnace. This ore is imbedded in a red clay, and seems to have been brought from its original position and deposited by water. The analysis gives—

e

	426.
	Per cent.
Iron	52.46
Phosphorus	0.332
Phosphorus in 100 parts iron	0.633

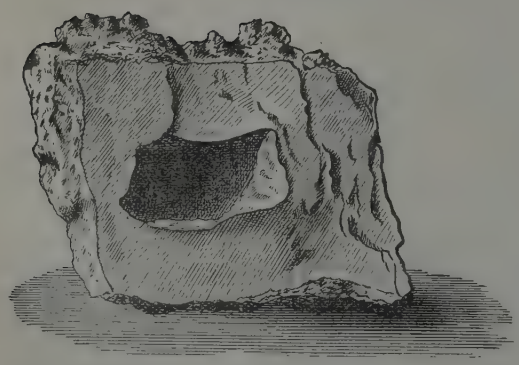


FIG. 150.

FIG. 151.

A mile and a half north of the Bartow furnace is a bed of limonite called the *Wheeler* bank. It is a solid mass of ore 25 to 30 feet in thickness, dipping about 50° from the horizontal to the east, between well-defined walls of talcose or hydromica-schist; the strike is nearly due north and south. It has been penetrated to a depth of 40 feet

in the old Etowah works, and is now being removed in several open cuts 15 to 20 feet deep. One hundred feet a west of the ore-bank is a quarry in which sandstone, well adapted to lining of furnaces, is found. Samples 427 and 428 are from this bank; the latter from the ore in place in the open cut near Mr. Wheeler's house, the former from a small exposure 200 yards off to the north. The analyses give:

	427.	428.
	Per cent.	*Per cent.*
Iron	56.57	51.62
Phosphorus	0.802	1.612
Manganese	0.23	0.33
Phosphorus in 100 parts iron	1.418	3.123

b

There are a number of places east of the Wheeler bank where ore has been dug in small quantities. Among these are the *Irish* and *Black* banks. They lie within a quarter of a mile of each other, 1 mile from Wheeler's. Neither has been extensively worked, and the amount of ore seen was small. The limonite of the Irish bank resembles sample 428; it is a compact brown ore. That of the Black bank has a much darker color and a brilliant luster. The following are the analyses of samples taken from the ore in place:

c

	IRISH.	BLACK.
	431.	432.
	Per cent.	*Per cent.*
Iron	57.42	54.71
Phosphorus	0.540	0.752
Manganese	0.15	0.40
Phosphorus in 100 parts iron	0.940	1.374

Three miles east of Wheeler's is the *Crow* bank; this has been quite extensively worked, and presents to view a face of ore 30 feet wide and 15 feet high between well-defined walls. The ore is a dense limonite, which incloses many irregular cavities, whose dimensions vary from a few inches to several feet. One of these "ruggs" that d been opened but not destroyed was about 6 feet long vertically, and 6 inches to 3 feet wide, the interior being filled with irregular projecting masses of ore covered with a brilliant black coating of manganese(?).

Associated with the hard limonite is a softer ore which has a much darker brown streak; but a small amount of it was seen. Samples 429 and 430 represent, respectively, the hard and the soft portions of this ore:

	429.	430.
	Per cent.	*Per cent.*
Iron	56.24	59.20
Phosphorus	1.124	0.502
Manganese	0.73	4.35
Phosphorus in 100 parts iron	1.999	0.848

e

The limonites north of Cartersville occur principally in a range of low hills which lie between the Tennessee and Wolf-Pen roads, and extend in a direction of north 20° east from 3 miles north of the town to the eastern boundary of the county. These hills also contain a number of deposits of manganese, and there are several banks in which the limonite and manganese ores are intimately associated in varying but approximately equal proportions. (See special report on the manganese ores.)

The nearest point to Cartersville where this range of limonites is opened is the *Giton* bank. This lies west of the Tennessee road on a steep hill about 75 feet above Pettit's creek. The ore is a compact limonite, occurring in large concretionary masses, associated with leaner portions, that consist of cemented fragments of white quartz and mica-schist(?). f

The bank had not been worked for many years, when visited, but it has since been reopened, and ore for a furnace, located near the railroad, about 2 miles from Cartersville, is being drawn from it.

The following is the analysis of the sample, taken as an average, of the ore exposed in the old workings:

	440.
Iron	*a* 48.89 *b* 48.97
Phosphorus	0.457
Phosphorous in 100 parts iron	0.935

a Ignited. *b* Not ignited.

a While the Giton bank forms the summit of a steep hill, the *Munford* bank, which lies half a mile northwest of it, is opened in a low mound of red clay in the bottom-lands of Pettit's creek. The Giton ore is evidently in place; the Munford ore consists of pebbles and rounded lumps apparently deposited in their present position, with the clay, in which they are imbedded. The writer did not determine whether this ore is an alluvial deposit or is segregated from residual clays. The latter seems most probable. Ore is being shipped from the Munford bank to Chattanooga.

Sample 439 was taken from a pile of ore at the bank. The following is the complete analysis:

b

	439.		439.
	Per cent.		*Per cent.*
Sulphur	0.008	Carbon in carbonaceous matter	0.08
Phosphorus	0.330	Hygroscopic water	0.33
Iron, metallic	55.69	Water of composition	9.69
		Total	100.056
Silica	4.49		
Iron, protoxide	0.48	Per cent. of insoluble silicious matter	6.95
Iron, peroxide	79.01		
Alumina	4.73	Silica	4.49
Manganese, protoxide	Trace.	Alumina	2.17
Lime	0.17	Lime	0.04
Magnesia	0.21	Magnesia	0.21
Carbonic acid	0.09		
Sulphuric acid	0.02	Total	6.91
Phosphoric acid	0.756		

c

It is 5 miles, in a direction a little east of north, from the Giton bank to the *Burford*. There are several deposits of manganese ore between the two, but no limonite that is now known.

A large amount of ore has been taken from the Burford bank, which is opened on the northern slope of the hill in which it lies. It is said to be capped by sandstone, but the old pits were too much fallen in to admit of any examination of the deposit.

d Sample 438 was taken from a small amount of the ore in place; the analysis gives:

	438.
	Per cent.
Iron	54.36
Phosphorus	0.201
Manganese oxide	0.45
Phosphorus in 100 parts iron	0.370

A mile beyond the Burford bank is another, known as the *Wild Cat*. This bank was not visited, but the ore e was sampled at the stock-pile of the Diamond furnace on Stamp creek. The greater part of it is a compact, brown limonite, but there are some light-yellow portions that are very hard, and closely resemble flint in appearance; this variety is called "liver ore", and is considered to be very good.

Sample 433 was taken as an average of about 10 tons of the common ore. Sample *a* 433 is a special analysis of a few small pieces of "liver ore", and 434 was taken as an average of the roasted and crushed ore at the furnace. The following are the analyses.

f

	WILD CAT BANK.		
	Liver ore.	Raw ore.	Roasted ore.
	a 433.	433.	434.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	60.93	50.64	63.40
Phosphorus	0.441	0.668	0.755
Sulphur	.....	0.179	.....
Silica	0.2	.....	.....
Water of composition	10.80	.....	.....
Phosphorus in 100 parts iron	0.723	1.319	1.191

The following is the complete analysis of 433. a

	433.		433.
	Per cent.		*Per cent.*
Silica	8.94	Hygroscopic water	0.63
Iron, protoxide	0.34	Water of composition	9.69
Iron, peroxide	71.82	Total	100.063
Alumina	4.24		
Manganese, protoxide	0.42	Per cent. of insoluble silicious matter	11.67
Lime	1.08		
Magnesia	0.63	Silica	8.94
Iron, disulphide	0.335	Alumina	2.29
Carbonic acid	0.40	Lime	0.19
Phosphoric acid	1.528	Magnesia	0.27
Carbon in carbonaceous matter	0.01	Total	11.69

b

There are three ore-banks about 10 miles north of Cartersville, beyond the cross-road that runs westward from Wolf Pen. The first of these is the *Peach Tree* bank, about 1 mile northwest of the Diamond furnace. The openings consist of two large cuts in the southeast side of a hill near the summit, which expose a fine-grained sandstone. Through this runs an irregular deposit of limonite that dips toward the east. The total thickness is about 20 feet, but not more than 6 feet can be considered good ore, the remainder inclosing angular fragments c of sandstone. A portion of this ore is stalactitic, but the greater part is a dark-brown, compact limonite.

Sample 435 was taken at the bank from the ore in place, the associated sandstone not being included. The analysis gives—

	435.
	Per cent.
Iron	59.16
Phosphorus	0.442
Phosphorus in 100 parts iron	0.747

d

Two miles west, on the other side of the range from the Peach Tree bank, is another of similar character, called the *Big* bank. The large irregular masses of ore to be seen in the open cuts on the summit of the very steep hill give an idea of a very large amount of ore, but even an approximate estimate would be very uncertain.

Sample 436 was taken from a pile of ore mined for the Diamond furnace. This pile contained pieces that inclosed sandstone fragments as well as pure ore. The sample was taken as an average of the total amount in the pile. The analysis gives—

	436.
	Per cent.
Iron	54.84
Phosphorus	0.649
Manganese oxide	0.12
Phosphorus in 100 parts iron	1.183

e

The *Connor* ore-bank lies but half a mile southwest of the Big bank, but the ore is very different. It is concretionary and partly stalactitic, like a limonite, but the streak is much too red for that ore. It appears to consist of hematite and limonite mingled, and to be derived from pyrite. It has been dug in an open cut to the depth of 10 feet in a low hill close by the roadside.

Sample 437 was taken as an average of about 3 tons mined for the Diamond furnace:

	437.
	Per cent.
Iron	60.12
Phosphorus	0.112
Phosphorus in 100 parts iron	0.186

f

There is one ore in the neighborhood of Cartersville that differs entirely from all others seen in Georgia. This is the specular ore of the *Gray* ore-bank, which is on the east side of the Etowah, about 2½ miles from the town. It lies in a very irregular bed, that varies from a few inches to 7 feet in thickness, and frequently changes its strike and dip. Its general trend is east and west. A tunnel 200 feet long had been run in to strike the ore, which had then been followed horizontally about 400 feet. This was abandoned in the autumn of 1878 (?), and had

a fallen in so as to be inaccessible when visited. Sample 441 was taken from ore found near the old Etowah workings, about 100 yards east of the tunnel. Sample 472 was afterward taken from a new opening some distance off to the west. The analyses are as follows:

	441.	472.
	Per cent.	*Per cent.*
Iron	53.89	57.00
Phosphorus	0.038	0.010
Sulphur	.....	0.006
Silica	21.79	16.67
Phosphorus in 100 parts iron	0.071	0.018

b

The following is the complete analysis of sample 472:

	472.		472.
	Per cent.		*Per cent.*
Silica	16.67	Water of composition	0.31
Iron, protoxide	0.44	Total	100.054
Iron, peroxide	80.95		
Alumina	1.34	Per cent. of insoluble silicious matter	17.55
Manganese, protoxide	Trace.		
Lime	0.09	Silica	16.67
Magnesia	0.11	Alumina	0.81
Carbonic acid	0.09	Lime	0.01
Sulphuric acid	0.02	Magnesia	0.05
Phosphoric acid	0.024		
Carbon in carbonaceous matter	0.01	Total	17.54

c

There are a number of deposits of limonite near Cedartown, in Polk county, that are worked for the large furnace of the Cherokee Iron Company. A mile west of the furnace, connected with it by a tramway, are many openings on both sides of a slight elevation. These are called the *Woods* bank, and their relative positions are d indicated in the following sketch (Fig. 152):

e

f

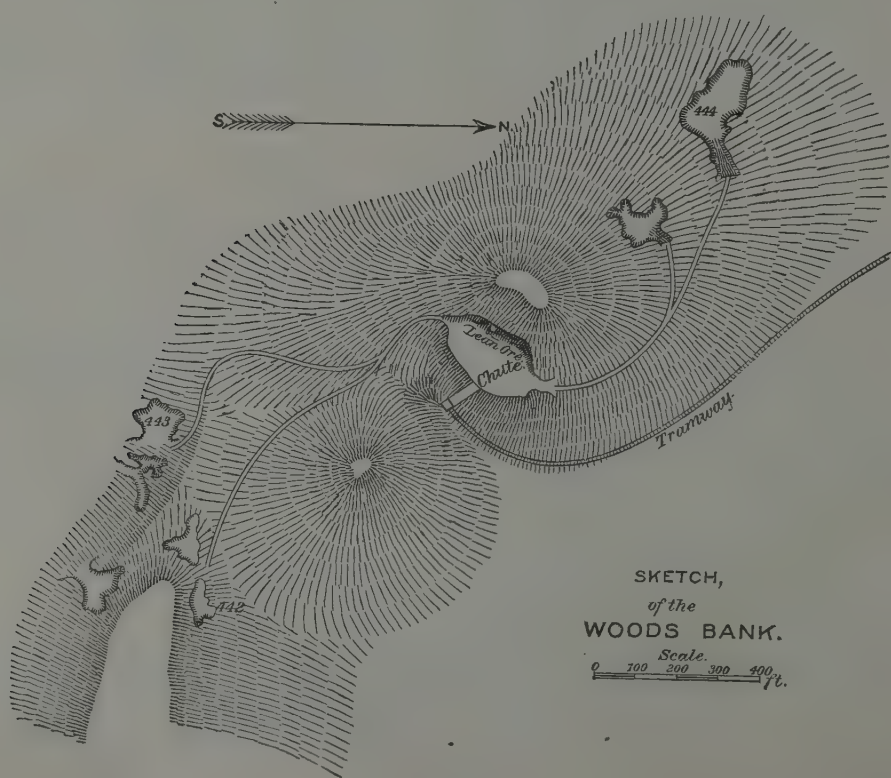


FIG. 152.

At the time this bank was visited it had been recently abandoned and the ore was well exposed in the different a openings. It is a dark-brown, compact limonite, partly massive, partly concretionary, with brilliant pitchy layers, that are almost black.

Three samples were taken from the openings marked with their respective numbers on the sketch. The following are the analyses:

	442.	443.	444.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	47.21	54.71	49.50
Phosphorus	1.134	1.256	1.537
Manganese	0.30	0.25	1.69
Phosphorus in 100 parts iron	2.402	2.296	3.105

b

A quarter of a mile from the Woods bank, in the general direction of this ore range, namely, north 10° east, is the *Peck* bank, which was just being opened for the Cherokee furnace.

The ore at this point is darker in color and contains more of the black, pitchy variety than that at the Woods bank, but is like it in texture and hardness. The analysis of a sample taken from the ore, as broken up for transportation to the furnace, gives— c

	445.
	Per cent.
Metallic iron	53.86
Phosphorus	1.080
Manganese	0.20
Phosphorus in 100 parts iron	2.005

The *Phillips* bank lies half a mile south of the Cherokee furnace, in a low mound that rises from the bottom-lands of a small creek. It was not visited, but sample 446 was taken from about 10 tons of the ore at the furnace. It is a compact limonite, associated with a small amount of hematite, as is apparent from the red streak obtained d from some specimens. The following is the analysis:

	446.
	Per cent.
Metallic iron	55.54
Phosphorus	0.178
Manganese	0.20
Phosphorus in 100 parts iron	0.320

e

Five miles east of Cedartown an outcrop of limonite crosses the road to Van Wert; this ore, it is said, can be traced 2 miles along a ridge that trends about north 10° to 20° east. It is considered to be a very large deposit and was soon to be opened for the furnace at Cedartown. It is known as *Fisher's Creek* bank.

A sample was taken from the outcrop, north of the public road. The following is the analysis:

	447.
	Per cent.
Metallic iron	46.60
Phosphorus	0.570
Manganese	0.14
Phosphorus in 100 parts iron	1.223

f

A number of ore-banks are opened in the western part of Polk county, near the Alabama line; five samples were taken in this vicinity, on the range which extends into Alabama. (See description of sample 252, *et seq.*, report of Mr. W. M. Chauvenet.)

The *Pennington* and *Alloway* banks belong to the Etna furnace, which is situated on the Selma, Rome and Dalton railroad, a mile from the Alabama line. The former of these banks is about 200 yards south of the furnace, the latter half a mile southwest of it. The ores are both compact, dark-brown limonites. Samples 448 and 449 were taken from stock-piles at the Etna furnace; the banks themselves were not visited.

a The following are the analyses:

	PENNINGTON.	ALLOWAY.
	448.	449.
	Per cent.	*Per cent.*
Metallic iron	55.00	54.90
Phosphorus	0.936	0.413
Manganese	0.20	0.05
Phosphorus in 100 parts iron	1.702	0.752

b

There are several other banks, belonging to the Etna furnace, in the immediate vicinity of these, but they were not open when the locality was visited.

The *Folger* bank is opened 1½ mile northwest of Prior's station. It is connected by a branch track with the Selma, Rome and Dalton railroad, and the ore has been shipped to Chattanooga. A broad ledge of ore has been stripped, exposing a very compact limonite, with dark color and brilliant luster; portions of it inclose angular fragments of chert. Sample 450 was taken from the ledge as a fair average of the ore in sight. The following is the analysis:

c

	450.
	Per cent.
Metallic iron	43.89
Phosphorus	0.412
Manganese	0.80
Phosphorus in 100 parts iron	0.939

A mile and a half north of Prior's station are several openings, known as the *Snake Pond* banks. These lie in the lowland between the public road and the railroad, and also just east of the former in the rising ground. Sample 452 is from one of the old openings near the railroad. The exposure of ore was small and possibly below the average in quality. An ore that closely resembles that of the Folger bank in appearance is opened on the d other side of the public road, but has never been worked. Sample 451 was taken from the ledge there exposed. The analyses are—

	451.	452.
	Per cent.	*Per cent.*
Metallic iron	42.06	35.43
Phosphorus	0.156	0.092
Manganese	4.05	0.40
Phosphorus in 100 parts iron	0.347	0.260

e The ores of Bartow and Polk counties are near the southeastern and southern limits of the Lower Silurian strata in Georgia. The belt of these rocks extends from these counties northward to the Tennessee line, and deposits of limonite are found in many localities in them, though they are not as numerous as in the neighborhood of Cartersville. There is a test-pit 2 miles west of Kingston, in Bartow county, on a high ridge, by the side of which a few pieces of ore are found. Sample 473 was taken from these, and the analysis is as follows:

f

	CALDWELL BANK.
	473.
	Per cent.
Metallic iron	53.04
Phosphorus	0.415
Phosphorus in 100 parts iron	0.782

This ore is a porous, concretionary limonite, the cavities of which are filled with red clay. It has never been worked.

Ridge Valley furnace is situated at the foot of the western slope of a range of hills having a northeast trend, in Floyd county, 9 miles north of Rome. It was built to work ores supposed to exist in inexhaustible quantities in these hills, but they have been worked out, and the furnace is supplied from distant banks by rail. Enough ore was found in the old pits on the ridge to show that there were several varieties. Sample 455 represents a hard,

laminated ore, which has a red streak, and more closely resembles a hematite than a limonite. Samples 453 and a
454 were taken from openings much farther up the hill; they represent a porous ore, that has the structure of a limonite, but a reddish streak. The following are the analyses:

	453.	454.	455.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	57.21	54.12	41.89
Phosphorus	0.086	0.095	0.044
Water of composition	8.90	13.65	5.80
Phosphorus in 100 parts iron	0.150	0.176	0.105

b

The *Flower Branch* bank was opened a mile north of the Ridge Valley furnace. The old pits had caved in and no ore was to be seen in place; but there was a small pile, containing about half a ton, from which the sample was taken. This pile contained two varieties of ore—one a very compact limonite, apparently free from foreign matter; the other a very hard, highly silicious ore. The sample was taken as an average of the entire pile. The ore could evidently be enriched by hand-picking. The analysis gives—

	456.
	Per cent.
Metallic iron	51.62
Phosphorus	0.095
Phosphorus in 100 parts iron	0.184

c

Snake Creek gap is an opening through Chattooga mountain, about 13 miles south of Dalton, near the common boundaries of Gordon, Walker, and Whitfield counties. In this gap, 2 miles west of Blue Springs station, there is a large, irregular pit, opened on a bed of compact, dark-colored limonite, much of which is black, with a brilliant luster. This ore extends along the ridge, showing itself in frequent outcrops to a distance of 4 miles south, and appears north of the gap, where it has a length of about 1 mile. The width of the bed exposed in the old pit is about 150 feet. Sample 474 was taken at this opening, which is on lot 270, twenty-sixth district, third section. The following is the complete analysis: d

	474.		474.
	Per cent.		*Per cent.*
Sulphur	0.258	Phosphoric acid	3.106
Phosphorus	1.359	Carbon in carbonaceous matter	0.06
Iron, metallic	51.41	Hygroscopic water	1.09
Phosphorus in 100 parts of iron	2.636	Water of composition	10.49
Silica	5.99	Total	100.087
Iron, protoxide	0.38		
Iron, peroxide	72.98	Per cent. of insoluble silicious matter	7.20
Alumina	5.36		
Manganese, protoxide	Trace.	Silica	5.99
Magnesia	0.24	Alumina	1.14
Iron, disulphide	0.071	Magnesia	0.07
Zinc, sulphide	0.21		
Carbonic acid	0.11	Total	7.20

e

The belt of Lower Silurian limonites appears to be very narrow in northern Georgia. The number of deposits is small, and they have not been worked. In Murray county, 12 miles north of Spring place, search was made for copper on the land of *J. R. Harris* at the time the Ducktown mines were opened. A shaft was sunk 60 feet and a tunnel driven 150 feet into a hill on lot 164, tenth district, third section. No copper was found, and the tunnel and the shaft are now inaccessible; but the porous limonite, which led to the exploration, still lies scattered over the f
surface of the hill. Sample 476 was taken from a number of such pieces. The following is the analysis:

	476.
	Per cent.
Metallic iron	55.35
Phosphorus	0.691
Phosphorus in 100 parts iron	1.248

Six miles beyond Mr. Harris' place, in Aliculsie valley, near the Tennessee line, there are two other deposits of limonite, which have been opened. One of these is near the road that runs through the little valley, on a wooded

a ridge. Nothing is to be seen but a few outcrops of highly silicious ore and an old shaft, said to have been sunk to a depth of 40 feet. The ore is represented by sample 477, taken from the outcrops. The other deposit referred to is called the *Calico* bank, possibly from the effect produced by the red and white clay that fills the hollows of the brown and bluish, scoriaceous limonite. Many years ago this ore was worked in a forge near by, but nearly all trace of the old diggings has disappeared. Sample 478 was taken from a small pile of the ore found near an old test-pit, on lot 238, twenty-seventh district, third section. The analyses of these two samples give the following results:

b

	477.	478.
	Per cent.	*Per cent.*
Metallic iron	32.17	46.78
Phosphorus	0.848	0.156
Phosphorus in 100 parts iron	2.636	0.333

Several outcrops of red fossil-ore occur near Ringgold and on Dick's ridge, 10 miles northwest of Dalton. A mile and a quarter north of Trickum a test-pit has been opened on lot 170, twenty-seventh district, third section, and a small amount of the ore thrown out. Sample 475 was taken from this ore. The thickness of the bed is unknown. The analysis gives:

c

	475.
	Per cent.
Metallic iron	58.36
Phosphorus	0.191
Phosphorus in 100 parts iron	0.327

NOTES ON THE SAMPLES OF MANGANESE ORE COLLECTED IN GEORGIA.

By Bailey Willis.

In the vicinity of Cartersville, Bartow county, Georgia, are numerous deposits of limonite and manganese ore; b the former are described in the report on the iron ores of Georgia. It is the purpose of this paper to give some account of the ore-banks of the "Pyrolusite Manganese Mining Company" and of other small openings worked by private parties for manganese.

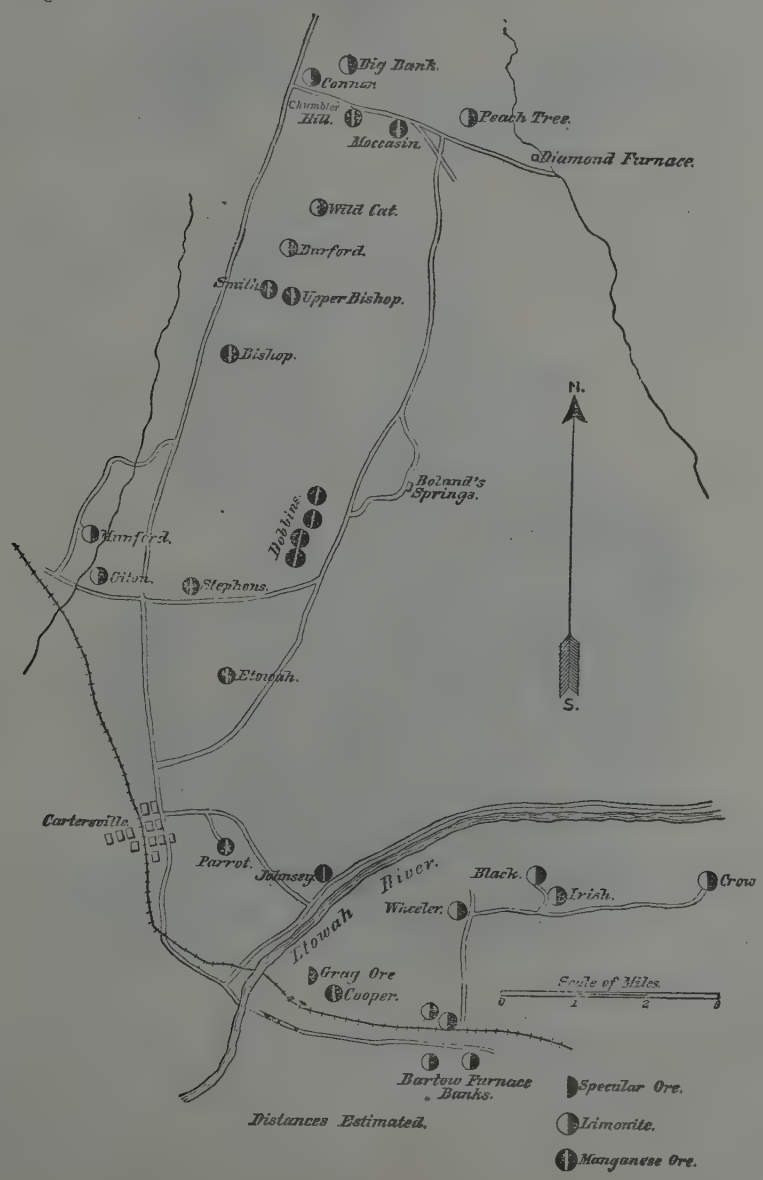
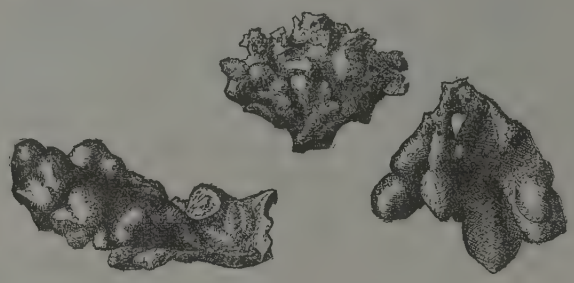


Fig. 153.—Sketch of Ore banks near Cartersville, Bartow county, Georgia.

a It will be seen by reference to the accompanying sketch-map that the limonites and manganese ores occur in a narrow belt running nearly north and south. From the Parrot bank northward the surface is formed of low hills, generally covered with woods, but, where cleared, often cut into deep, red gullies. It is in the clay, to which this last effect is due, that the manganese is commonly found. There are two kinds of the ore, which occur together in the same banks and sometimes in the same hand-specimens; the one is pyrolusite, in its common form of needle-like crystals, the other a hard, steel-gray, concretionary ore—psilomelane? They are found in nodules, usually but a few inches or at most a foot in diameter, enveloped in the bright-red clay, through which they are irregularly scattered. Large masses of the mingled ores occur in some banks and have the same general concretionary structure, though on a greater scale. Although deposited in the same strata the iron ores are not usually b intimately associated with manganese.



c

FIG. 154.—PSILOMELANE. FROM THE JOHNSEY BANK, BARTOW COUNTY, GEORGIA.

At the Parrot and the Etowah banks limonite and psilomelane do occur mingled in the solid mass, but even there each mineral is distinctly separate from the other, so that the streak and other physical characteristics of each are readily recognizable. The pyrolusite is locally known as the "black" or "soft" ore; the psilomelane as "potato" ore, from its frequent resemblance to Irish potatoes; and a long, slender stalactitic form found at one locality is sometimes called "rat-tail" ore.

d

e

f

FIG. 155.—PSILOMELANE? ENVELOPED IN PYROLUSITE. FROM STEPHENS BANK, BARTOW COUNTY, GEORGIA.

Cooper's bank is the only one opened south of the Etowah river; it is quite new, and the deposit could not be examined when visited. A shaft had been sunk on the summit of a ridge and a small amount of ore had been taken out; this was separated into two qualities—first and second; the former consisted of nearly pure pyrolusite, said to be most abundant near the bottom of the shaft; the latter was the psilomelane, taken from nearer the surface. A tunnel was being driven in to strike the deposit at some depth in order to obtain the greatest possible

[The analyses of the samples collected by Mr. Willis, and referred to in this report, were not made, as it was found necessary to confine laboratory work to the iron ores.]

proportion of first-class ore. Another small opening near by has furnished a third-class ore, which is associated a with limonite and red clay. These three qualities of ore are represented, respectively, by samples Nos. 457, 458, 459.

The road that leads eastward from Cartersville crosses a ridge in which the Parrot bank is opened and descends into the valley of the Etowah, here spreading into a strip of bottom-land that is bounded by the rapid river on the south and low hills on the north. On one of these gentle slopes Mr. Johnsey has made a small opening in the clay, and has obtained a considerable quantity of psilomelane; the pieces of ore are all small and disconnected; each one shows a fractured surface, indicating that it has been detached from another mass, and they are undoubtedly not in place. Sketches of several typical forms are herewith given (Fig. 154):

The Parrot bank was not visited, but a small amount of the ore was seen at the manganese works in Cartersville; it consists of psilomelane (?) and limonite mingled, and resembles that of the Etowah bank. The latter lies about b 2¼ miles north of Cartersville on a ridge 75 or 100 feet above the Wolf Pen road. An irregular surface of ore has been exposed by stripping; it is massive and made up of limonite intimately associated with psilomelane (?). Each retains, however, it's streak and all physical characteristics, apparent to the eye; both are concretionary and stalactitic.

Sample 461 was taken as an approximate average of the total exposure, as the two ores could only be partially separated, by even careful hand-picking.

There is a little hollow north of the Etowah bank through which a cross-road runs east and west. Quite near this road, 3½ miles from Cartersville, is a small opening called the Stephen's bank. Nodules of psilomelane (?) and pyrolusite occur scattered through the clay, and a small pile of these lay by the side of the test-pit. One of them c is sketched in Fig. 155:

d

e

Fig. 156.—Psilomelane? From Dobbin's bank, Bartow county, Georgia.

Dobbins' bank, near the Wolf Pen road, 5½ miles north of Cartersville, has been more extensively worked than any of the others, excepting, perhaps, the Chumbler hill. There are several openings, one of which is called the "Black" bank, because a very large proportion of the ore found there is pyrolusite. Farther north are large open cuts, which have in places been worked to a depth of 40 feet. The ore nodules lie in beds 6 to 8 feet thick, dipping f to the east; they are inclosed in red clay and limited along the strike, the greatest length yet found being 120 feet. The proportion of pyrolusite in the ore is said to increase as the bed descends. The hard and soft ores are usually kept separate.

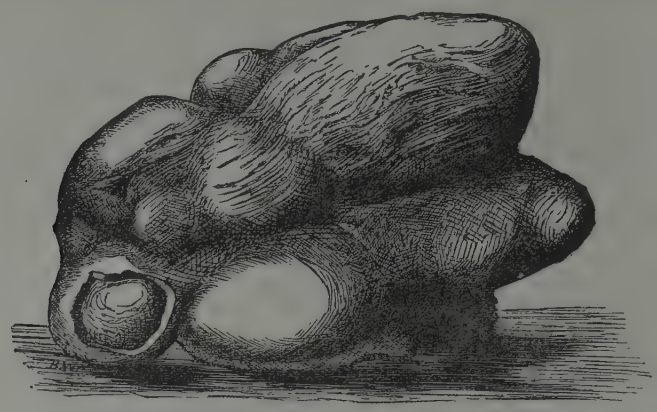
Samples 462 and 463 were taken at the northern opening and 464 from a pile of ore at the "Black mine".

The Moccasin and Chumbler Hill banks are on a cross-road that runs east and west past Wolf Pen. The former is a small open cut close by the road, in which psilomelane, forming concretions around sandstone masses, and irregular deposits of wad, are found. The ore is not considered as good, and being in large masses is more difficult to obtain than that found elsewhere; hence but little has been removed. The Chumbler Hill bank has been very extensively worked, and next to the Dobbins is the best developed. The ore lies in small concretions and also in large concretionary masses, which contain a large proportion of crystallized pyrolusite. Fig. 157 is a sketch of a specimen of psilomelane (?) from this bank.

a The fracture in the lower left-hand corner shows well the concentric formation of these nodules.

Samples 465 and 466 were taken from ore in place at the Moccasin bank, and 467 was collected at the Chumbler hill.

b



c FIG. 157.—PSILOMELANE? FROM CHUMBLER BANK, BARTOW COUNTY, GEORGIA.

The Smith bank, the Upper Bishop, and the Bishop are all small openings not far from the Tennessee road, between 6 and 7 miles north of Cartersville. The ore is nodular, partly crystallized pyrolusite, partly the hard amorphous ore, probably psilomelane. Sample 468 was taken from a little ore found in the old open cut of the Smith bank, not worked at present, and samples 469 and 470 are from the Bishop bank proper. No ore was seen at the Upper Bishop.

NOTES ON SAMPLES OF IRON ORE COLLECTED IN ALABAMA.

By W. M. Chauvenet.

The iron ores of Alabama, represented by the samples taken, may be divided into three principal groups: The limonites; the red fossil or dyestone ores; the blackbands.

The limonites of the first group are divided by Eugene A. Smith, state geologist, as follows: (1) The Silurian limonites associated with the Knox dolomite; (2) the limonites of the Carboniferous age occupying the ridges of the anticlinal valleys of middle Alabama.

The working deposits of limonite are confined to the region adjoining and extending along the Selma, Rome, and Dalton railroad from Bibb county to the eastern limit of Cherokee county at the Georgia line, and to a smaller area in Bibb and Tuscaloosa counties in the vicinity of Woodstock and Green Pond stations on the Alabama and Chattanooga railroad.

The samples taken from the second group of limonites, namely, the Carboniferous limonites, were from small abandoned pits worked for forges before 1860.

The dyestone or red fossil ores of the Red Mountain group can be traced almost continuously from the extreme south of Jefferson county northeasterly to the Georgia line in DeKalb county, a distance of 130 miles, in Alabama alone. This great range of ores had up to the fall of 1879 been opened but at two points for mining purposes—one at Eureka mine, at Oxmoor station on the South and North Alabama railroad, in Jefferson county; a second at the Irondale mine, 5 miles east of Birmingham, also in Jefferson county.

On the west of Roup's and Jones' valleys, in Jefferson county, the ore ridges are duplicated, and to this portion of the dyestone range has been given the name of Little Red mountain. On this portion of the ore no openings have yet been made for mining purposes.

An isolated group of fossil ores is found in Cherokee county, described by M. Tuomey (*Geology of Alabama* 1858, p. 27), as follows:

> That part of Cherokee county between the base of Lookout mountain and the Coosa river is composed of two ridges parallel with the river from Wills creek where it crosses the valley to the Blue ponds. The ridge next to the mountain is composed, beginning at the base, of the magnesian and colored limestones, succeeded by a bed of yellow and brown sandstone, in which the bed of red "fossiliferous ore" is contained, the whole dipping northwest.

In this group are two openings for mining purposes, hereafter to be described.

The blackband ores are mined only at one locality—at the mines of The Newcastle Coal and Iron Company, at Newcastle station, Jefferson county.

The accompanying geological map of Alabama (Plate XXXVI) shows the three formations in which the ores sampled occur, while the geographical map (Fig. 158) shows the location of the banks from which samples were taken.

The sampling of the ores of Alabama will be considered, and the deposits described according to the above grouping.

SILURIAN LIMONITES.

Work was begun upon the Silurian limonites in Bibb and Tuscaloosa counties.

Sample 223 was taken from a pile of loose lumps thrown from a small prospecting pit opened in the *Strickland* bed for the use of the Edwards Iron Company, at Woodstock, in Bibb county. The bed is in Bibb county, SE. $\frac{1}{4}$, Sec. 10, T. 21, R. 6 W., and is not yet fully opened. The ore occurs in loose masses, varying in size from a small pebble to masses tons in weight, imbedded in reddish sandy clay. The ore is a dense brown limonite, with black pitch-like streaks, and shows, upon analysis—

	223.
	Per cent.
Metallic iron	48.16
Phosphorus	0.944
Phosphorus in 100 parts iron	1.960

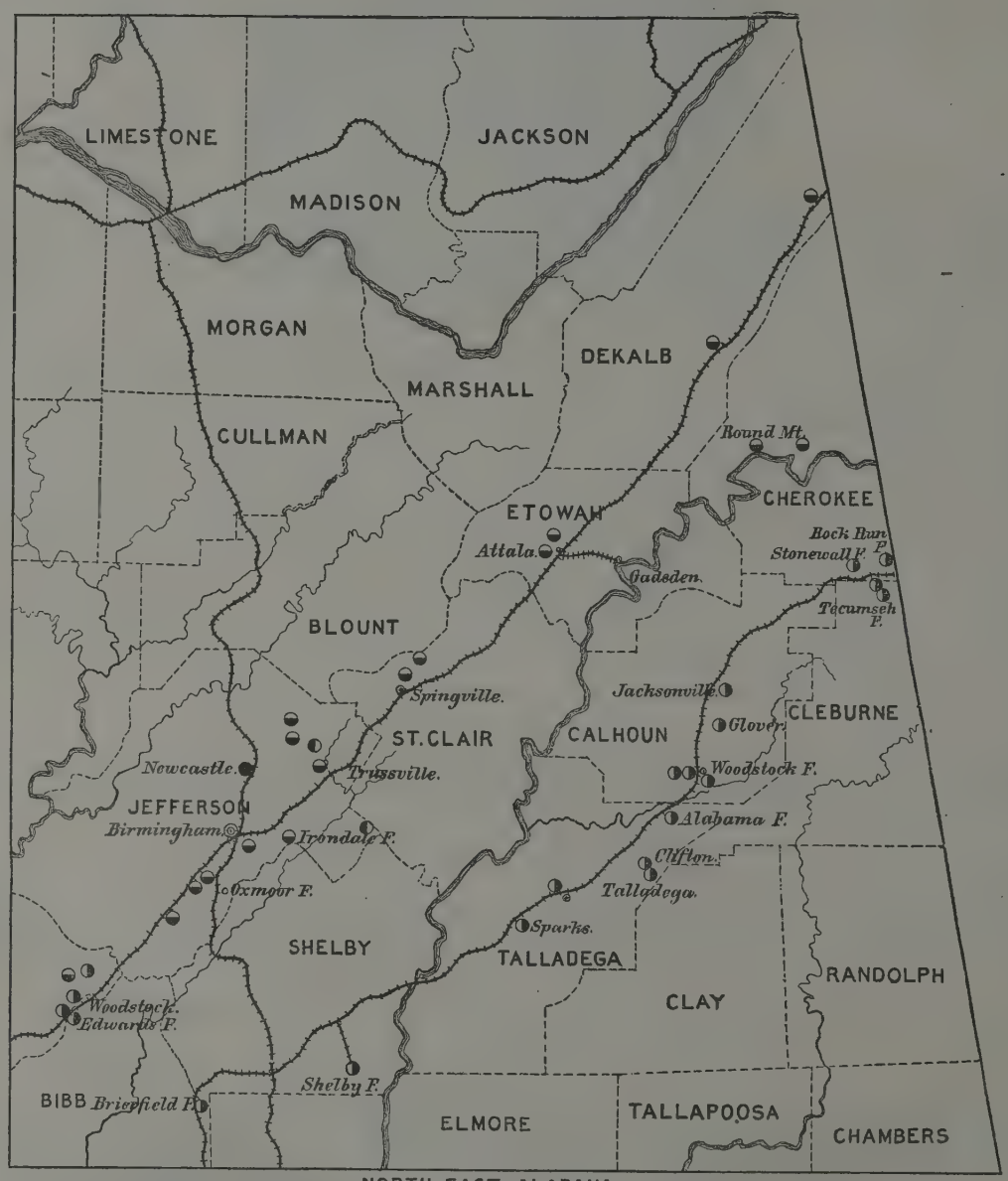

LIMESTONE
JACKSON
MADISON
MORGAN
DEKALB
MARSHALL
CULLMAN
Round Mt.
CHEROKEE
ETOWAH
Attala.
Gadsden.
Rock Run P.
Stonewall F.
Tecumseh F.
BLOUNT
Springville.
Jacksonville.
CLEBURNE
Glover
ST. CLAIR
CALHOUN
Newcastle.
Trussville.
Woodstock F.
JEFFERSON
Birmingham.
Irondale F.
Alabama F.
Clifton.
Oxmoor F.
Talladega.
Sparks.
SHELBY
TALLADEGA
RANDOLPH
CLAY
Woodstock.
Edwards F.
Shelby F.
BIBB
Brierfield F.
ELMORE
TALLAPOOSA
CHAMBERS
Scale.
Miles.
5
10
20
NORTH EAST ALABAMA
SHOWING
IRON ORE DEPOSITS.
Silurian Limonites.
Carboniferous Limonites.
Brystone Ores.
Black Band Ores.

FIG. 158.

The ore from the west side of the branch which divides the Strickland bed was sampled from four small prospecting pits. The ore differs little in appearance from that on the east side of the stream, showing, upon analysis, however, a decided difference, which may be accounted for partly by the small amount of ore from which the samples were necessarily drawn. The analysis shows—

	224.
	Per cent.
Metallic iron	41.48
Phosphorus	0.878
Phosphorus in 100 parts iron	2.117

The *Burns* bed, on land of Mr. Edwards, is west of the Strickland bed, and has not yet been opened. It shows a large outcropping of boulders of limonite, which were sampled on both sides of the ravine which divides the deposit. The analysis shows—

	225.
	Per cent.
Metallic iron	47.11
Phosphorus	0.764
Phosphorus in 100 parts iron	1.622

These deposits of limonite in yellow and red sandy clay are exceedingly irregular, both in form and extent. The hills in this vicinity show large outcropping masses of the ore, often hundreds of tons in weight, and smaller loose lumps are scattered over the surface of the hills. These pieces of loose ore do not, in all cases, indicate an underlying bed of limonite.

Crossing into Sec. 11, T. 21, R. 6 W., Bibb county, the limonite, similar in occurrence, though perhaps of lighter brown color, is found in the *De Bardeleben* bank. This ore, sampled in a pit 100 feet long, by some 40 feet wide, shows, upon analysis—

	226.
	Per cent.
Metallic iron	46.54
Phosphorus	0.221
Phosphorus in 100 parts iron	0.475

The bank is close beside the track of the Alabama and Chattanooga railroad. The ore was mined for the South Pittsburgh furnaces, Tennessee, and shows low phosphorus. The limonites on the property of the *Pioneer Iron Company* occur along a continuous ridge, and were sampled from three openings on the bank a quarter of a mile apart. These openings are in the SE. ¼ of Sec. 30, T. 20, R. 5 W. Sample 228 shows, upon analysis—

	228.
	Per cent.
Metallic iron	48.59
Phosphorus	0.491
Phosphorus in 100 parts iron	1.010

This bank was worked in 1862 and 1863 for use at Roup's Valley Iron Works, now in ruins.

One mile north of this, in Tuscaloosa county, SE. ¼ of Sec. 29, T. 20, R. 5 W., is an extensive bank belonging to the *Tuscaloosa Iron Company*. Sample 229 was here taken from three openings extending along the ridge in a northeast and southwest course and determining the strike of the bed. The ore is a dark-brown limonite, cleaving, when struck, into thin slabs of irregular shape, and showing a black coating on the cleavage surfaces. It occurs imbedded in yellow clay, and is worked as in all other cases in the region under discussion in open cuts. The sample shows, upon analysis—

	229.
	Per cent.
Metallic iron	48.12
Phosphorus	1.021
Phosphorus in 100 parts iron	2.122

The ore was being shipped to the South Pittsburgh furnaces, Marion county, Tennessee.

a The bank of the *Eureka Iron Company*, held under lease, is in NE. ¼ of Sec. 2, T. 21, R. 6 W. The ore is a limonite occurring in red clay in irregular masses, as described above. It seems to be one of the best of these limonites, and shows, upon analysis—

	230.
	Per cent.
Metallic iron	46.59
Phosphorus	0.179
Phosphorus in 100 parts iron	0.385

b The following is the complete analysis of No. 230:

	230.		230.
	Per cent.		*Per cent.*
Sulphur	0.318	Phosphoric acid	0.410
Phosphorus	0.179	Carbon in carbonaceous matter	0.20
Iron, metallic	46.59	Hygroscopic water	0.84
		Water of composition	9.23
Silica	15.07	Total	100.095
Iron, protoxide	0.26		
Iron, peroxide	65.89	Per cent. of insoluble silicious matter	18.04
Alumina	5.41		
Manganese, protoxide	0.72	Silica	15.07
Lime	0.65	Alumina	2.89
Magnesia	0.25	Lime	0.10
Iron, disulphide	0.595	Magnesia	0.04
Carbonic acid	0.57	Total	18.10

c

It is washed and shipped to Oxmoor furnace, in Jefferson county. Returning to Woodstock station limonites were found exposed in a prospecting trench on the property of Dr. *Ray*, of Woodstock.

Here, in SE. ¼, Sec. 15, T. 21, R. 6 W., Bibb county, the hill rises rapidly from the track of the Alabama and d Chattanooga railroad, and sample 231 was taken on the crown of the hill, and from a second prospecting pit 400 yards east of the crown. The ore is a dense limonite showing no peculiarities. The analysis shows—

	231.
	Per cent.
Metallic iron	47.77
Phosphorus	0.923
Phosphorus in 100 parts iron	1.932

Sample 232 was taken on Dr. *Ray's* property in SE. ¼, Sec. 16, T. 21, R. 6 W., from a short trench from which e loose lumps of ore had been thrown and which exposed large masses imbedded deeper in the yellow clay at the bottom. This ore shows, upon analysis—

	232.
	Per cent.
Metallic iron	54.26
Phosphorus	0.266
Phosphorus in 100 parts iron	0.490

The next sample was taken on the property of *S. H. Woodward* from outcropping bowlders of limonite. The f bank located by the outcrop is in Tuscaloosa county, in W. ½ Sec. 10, T. 21, R. 6 W. The analysis of the sample gives—

	233.
	Per cent.
Metallic iron	56.12
Phosphorus	0.444
Phosphorus in 100 parts iron	0.791

These ores are widely spread and are found in every hillside throughout the region just gone over; the ores differ little in appearance, all showing dense-brown, smooth fracture and black, mammillary, pitchy-looking surfaces, showing fewer pots and honeycombed masses than the ores next to be described, lying along the Selma, Rome, and Dalton railroad.

The limonites so extensively mined along the line of the Selma, Rome, and Dalton railroad were first sampled **a** at the *Brierfield Furnace* banks. The banks are 1¼ mile northwest of the now abandoned furnace, and are much fallen and covered. The ore is a dense, cherty limonite, imbedded in yellow sandy clay, at times showing honeycombed masses, and pitchy mammillary surfaces are common. The ore was worked in open cuts which cover the low hills on the sides of the Montevallo road in SE. ¼ Sec. 21, T. 24 N., R. 11 E. No system seems to have been followed in mining these ores, the pits being very irregular in shape, and seeming to follow the richest masses of the bed. Sifters were here used to separate the finer chert lumps and the clay from the ore. This ore has been long celebrated in Alabama. The sample here taken is from many of these irregular openings from such loose lumps or outcropping masses as could be found. The analysis of this ore gives—

b

	234.
	Per cent.
Metallic iron	49.12
Phosphorus	0.265
Phosphorus in 100 parts iron	0.540

Though quite a good limonite by this showing, there is no reason why it should produce finer iron than the ores above shown from Eureka mine, in Tuscaloosa county, sample 230.

Going northeast upon the Selma, Rome, and Dalton railroad, the next working deposits of limonite visited **c** were at Shelby. Here, in SE. ¼ Sec. 13, T. 22 S., R. 1 W., in Shelby county, the *Shelby Iron Company* own and work extensive banks of limonite. The whole of the low hill northeast of the furnaces, which are two in number, is a network of irregular shallow pits and diggings. The ore occurs in small lumps scattered through red clay, and is a dense, dark-colored limonite, often in huge masses. The Shelby ore is peculiar in the many concretions lined with stalactites of a brilliant bronze hue, and in the huge pots and cavities lined upon the inner surfaces with a pitchy-black coating. Fine specimens of fibrous limonite are also found, the needles often from 6 to 8 inches in length. The finer ores dug from the clay banks with their accompanying clay are washed, and in many instances roasted, though much of this ore is also used raw. The main pit at the bank exposes a face of ore rising in a wall 45 feet in height and as many wide. This huge mass of ore shows great cavities and gnarled and twisted surfaces, varied in color from dense black to a very light brown. Three samples were taken from the *Shelby* **d** banks, all of them from such pits as are at present worked. The following are the analyses of these ores:

	235.	236.	237.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	52.82	53.92	49.64
Phosphorus	0.241	0.282	0.137
Phosphorus in 100 parts iron	0.456	0.523	0.276

Sample 235 is from the washer, and shows washed ore from one pit. The ore occurs in small lumps and fragments of hollow pots loosely scattered through a yellow clay. Sample 236 is from the stock-pile at the furnaces, **e** and represents ore from many parts of new and old diggings. Sample 237 is from the face of the great wall in the main pit above described, taken across the whole face. Sample 235 has been subjected to full analysis, with the following result:

f

	235.		235.
	Per cent.		*Per cent.*
Sulphur	0.139	Carbon in carbonaceous matter	0.09
Phosphorus	0.241	Hygroscopic water	0.87
Iron, metallic	52.82	Water of composition	9.62
		Total	100.031
Silica	6.62		
Iron, protoxide	0.34	Per cent. of insoluble silicious matter	7.89
Iron, peroxide	74.88		
Alumina	3.30	Silica	6.62
Manganese, protoxide	1.41	Alumina	1.17
Lime	0.82	Lime	0.08
Magnesia	1.02	Magnesia	0.04
Iron, disulphide	0.260		
Carbonic acid	0.25	Total	7.91
Phosphoric acid	0.551		

The next furnace using the ores of this region is the *Alabama furnace*, at Alabama station, Talladega county. Its ores are drawn from a wide range of country, all of which, however, lies adjacent to the Selma, Rome, and Dalton

a railroad. The first banks visited were those on the furnace property, which are now abandoned. These banks are in Sec. 17, T. 17, R. 7 E., half a mile from the furnace. The ore presents no peculiarities, being medium brown color, with reddish surfaces at times. The mine is an irregular open cut 30 feet deep and some hundred feet across. Analysis of this ore shows—

	240.
	Per cent.
Metallic iron	53.45
Phosphorus	0.912
Phosphorus in 100 parts iron	1.706

b

The *Talladega* ore-bank in Sec. 20, T. 18, R. 5 E. is represented by sample 238, sampled on the cars at Alabama furnace, and is part of the furnace ore property. The ore is a dark-brown limonite with concretions composed of short, silky, fibrous ore, its cavities filled with red ocher and at times with white sandy powder. The analysis of this sample gives—

	238.
	Per cent.
Metallic iron	54.23
Phosphorus	0.181
Phosphorus in 100 parts iron	0.334

c

The principal banks which supply Alabama furnace are in T. 18, R. 6, Talladega county, and are known as the *Clifton* banks. These ores have but recently been opened for furnace use, and are different from any other limonites sampled in this vicinity. The bank was being worked in an open cut, known as pit No. 1, which, when visited, was 15 feet deep and 30 feet across. The ore is a spongy, honeycombed, rather light limonite, showing dark-brown and light-yellow streaks, and containing included masses of soft, white chert, usually square-cornered, often triangular in shape. At the time when sample 241 was taken this bed was showing large quantities of this white silicious matter which covered the working-face with its powder under the tools of the miner. The small pit showed a wall of ore 15 feet high which seemed to dip deeper from the surface as it went southward. The ore is imbedded in yellow d clay and is exceedingly irregular in occurrence, the small pit under consideration showng nothing but clay with white masses of chert on two sides and limonite in odd lumps and streaks on the bottom. The wall of ore on the south seemed to be a huge boulder. The analysis of this sample shows—

	241.
	Per cent.
Metallic iron	48.74
Phosphorus	0.011
Phosphorus in 100 parts iron	0.023

e The same ore was sampled on the pile at Alabama furnace, and shows, upon analysis—

	239.
	Per cent.
Metallic iron	52.40
Phosphorus	0.047
Phosphorus in 100 parts iron	0.090

This pile showed less white chert than that from which sample 241 was taken.

Bed No. 6, on the Clifton property, had been opened on the crown of a hill 100 feet high by two trenches. The f ore thrown from this pit presented a beautiful appearance. It is a very light, spongy ore, exceedingly porous, its many cavities divided by thin, laminated walls. When freshly mined the ore, especially in the lining of its cavities, is highly colored—blue, green, and brilliant reds and yellows being most common. These colors fade upon exposure to the air. The more solid parts of the lumps are a dark-brown shade, and the whole lump assumes this shade after some weeks of exposure.

The sample taken at these two pits, from some hundred tons of ore, shows upon analysis—

	242.
	Per cent.
Metallic iron	52.22
Phosphorus	0.041
Phosphorus in 100 parts iron	0.078

The pits were 100 yards apart. The low per cent. of phosphorus in these ores distinguishes them from other limonites taken on the Selma, Rome and Dalton railroad, the Skinner bank being excepted. These pits upon the Clifton bank, No. 1 and No. 6, as above, are in Sec. 26, T. 18, R. 6.

The *Leay* bed on the same property is also in Sec. 26, and was worked in 1862 for a forge on a near stream. It shows bowlders in red clay, with none of the accompanying white chert. The ore is porous at times, at times argillaceous, and shows, upon analysis—

	243.
	Per cent.
Metallic iron	51.98
Phosphorus	0.100
Phosphorus in 100 parts iron	0.193

The pit is fallen and covered, and the sample was taken from such lumps as could be found exposed. The complete analysis of sample 242 is as follows:

	242.		242.
	Per cent.		*Per cent.*
Sulphur	0.109	Carbonic acid	0.34
Phosphorus	0.041	Phosphoric acid	0.934
Iron, metallic	52.22	Carbon in carbonaceous matter	0.26
		Hygroscopic water	0.55
Silica	9.42	Water of composition	10.55
Iron, protoxide	0.19	Total	100.183
Iron, peroxide	74.31		
Alumina	1.80	Per cent. of insoluble silicious matter	11.09
Manganese, protoxide	1.00		
Lime	0.34	Silica	9.42
Magnesia	0.23	Alumina	1.50
Iron, disulphide	0.119	Lime	0.07
Nickel, sulphide	0.14	Magnesia	0.12
Cobalt, sulphide	Trace.		
Copper, sulphide	Trace.	Total	11.11

The furnaces of the Woodstock Iron Company are situated at Anniston, on the Selma, Rome, and Dalton railroad, in Calhoun county. The ores of this company are brought from many banks located in both Talladega and Calhoun counties, along the line of the railroad. The ores sampled were from the following banks: The *Sparks* bank, in T. 19, R. 4 E., Talladega county, sampled on the cars at Woodstock furnaces. The pit is one of some importance; the ore is cherty and dense, showing, upon analysis, low phosphorus.

	244.
	Per cent.
Metallic iron	54.09
Phosphorus	0.118
Phosphorus in 100 parts iron	0.218

The *Side* bank is in the same town and range as the Sparks bank. The ore from many banks worked by the Woodstock company is brought to the furnaces by farmers, and may come from any of the hills within 10 miles. Many of these banks are nameless, and the ore brought in by ox-teams is accepted or rejected, as the inspector sees fit. The Side bank shows a soft argillaceous limonite, with occasional dense, cherty lumps, and sampled from the cars at Woodstock, gives, upon analysis—

	245.
	Per cent.
Metallic iron	47.12
Phosphorus	0.149
Phosphorus in 100 parts iron	0.316

The *Glover* bank is in Sec. 21, T. 15, R. 8 E., Calhoun county. The ore sampled at the Woodstock furnace, on the cars, from 50 tons, was a soft, clayey limonite, with occasional dense, hard lumps. This bank was opened in 1879. Analysis of the sample gives—

	246.
	Per cent.
Metallic iron	45.37
Phosphorus	0.048
Phosphorus in 100 parts iron	0.105

a The *Old Oxford* bank, near the furnaces, in Sec. 7, T. 15, R. 8 E., has been worked by the Woodstock company for eight years, and by the Oxford furnace, now abandoned, for many years previous. The sample was taken from two adjoining pits, on the top of the main hill, from a rough face of ore in one farthest west, and from a pile of loose lumps in a second, some 200 yards east. This bank is riddled by pits and trenches, and is much worked out. Analysis of this sample gives—

b

	247.
	Per cent.
Metallic iron	49.92
Phosphorus	0.147
Phosphorus in 100 parts iron	0.296

The ore is a dense, light-colored limonite in a very red clay which fills the cavities of the ore.

The *Skinner* bank, one-quarter mile west of the furnaces, on the west side of the ridge, is worked exclusively for the Woodstock company. The opening upon this bank is 20 feet deep and 50 feet long. The ore-masses are surrounded by a sticky, marbleized clay, streaked with white, red, and yellow. The ore is worked by pulling down the bank and picking the ore from the clay. The ore is a porous, brown limonite, giving, upon analysis—

c

	248.
	Per cent.
Metallic iron	48.62
Phosphorus	0.031
Phosphorus in 100 parts iron	0.063

The *Washer* bank shows a very red clay, in which the ore occurs in fine lumps and shells of broken pots. The ore is put through a washer, direct from which sample 249 was taken. This bank lies half a mile west of Anniston, in Sec. 7, T. 15, R. 8 E., Calhoun county, and had been opened five years. The analysis shows—

d

	249.
	Per cent.
Metallic iron	52.14
Phosphorus	0.113
Phosphorus in 100 parts iron	0.217

The company work other banks in Secs. 8, 32, and 34, T. 15, R. 8 E., but these are of small importance. A few of the banks in this region show manganese in workable quantity, and the Woodstock company have used the ore from section 34 for a mix in the manufacture of spiegel iron. The pit is now exhausted, fallen, and abandoned. The per cent. of manganese in the ore was very variable.

The banks of the *Stonewall Iron Company* are two in number, situated upon the furnace property in Sec. 15, e T. 12, R. 11 E., on the line of the Selma, Rome, and Dalton railroad, in Cherokee county.

The "Lower" bank, southeast of the furnace, is opened by a square pit 30 feet deep, exposing boulders of ore protruding from the bottom, and seams of ore dipping 30° in the northwest wall imbedded in yellow clay with large red masses. The ore is a dark-brown limonite with black streaks and velvety cavities, and was first worked in 1873. The sample taken from all parts of the pit shows, upon analysis—

f

	250.
	Per cent.
Metallic iron	41.45
Phosphorus	0.676
Phosphorus in 100 parts iron	1.631

The "Upper" bank is opened 60 feet below the crown of the high hill northwest of the furnace. The ore is associated with yellow clay and much yellow chert, and occurs in large masses. It is a very dense, brown limonite, showing little black in the cavities, and giving, upon analysis—

	251.
	Per cent.
Metallic iron	42.52
Phosphorus	0.301
Phosphorus in 100 parts iron	0.708

The *Tecumseh furnace*, 1 mile southeast of the Selma, Rome, and Dalton railroad, in Sec. 24, T. 12, R. 11 E., a Cherokee county, is in a region most productive of limonite ores. The hills back of the furnace both south and east covered with loose lumps, indicating the underlying beds. This ore is mined by the farmers in the vicinity, permission for such mining being obtained from the company when the ore is upon company property. In this way as many as fifty banks of limonite are opened and worked from time to time within a radius of 6 miles. These ores are dense, brown limonites.

The following banks were sampled: The *Terry* bank, Sec. 18, T. 12, R. 15 E; the *Treadaway* bank, in Sec. 29, 12, R. 12 E.; the *Brown* bank, in section 30, same township and range. Besides these, samples were taken from the stock-piles at the furnace, made up of mixed ore from all the company's banks.

The largest exposure of limonite seen upon this range was that at the Brown bank, above mentioned. Here a b pit 40 feet deep and over 200 feet long has been excavated upon the almost solid ore-mass, which is seen rising in rough masses and ledges on all sides, occupying also the bottom of the pit. The hills above the cut are covered with outcropping ledges and boulders of the ore. The ore presents many varieties, both in texture and in color, and in the southeast corner of the pit a recent blast had exposed a surface of much blackened ore, probably due to the binoxide of manganese. Pots and concretions are common, the interior cavities often crossed by stalactites, showing, when broken, a radiating structure. The following analyses show the nature of these limonites: No. 252 is from the Terry bank; No. 253 from the Treadaway bank; No. 254 from the furnace stock-pile, representing many banks; and No. 255 from the Brown bank: c

	252.	253.	254.	255.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	50.04	48.44	51.50	52.07
Phosphorus	0.108	0.584	0.908	0.838
Phosphorus in 100 parts iron	0.215	1.206	1.761	1.609

Besides these banks the Tecumseh furnace uses ore from the *Jacksonville* bank, in Sec. 12, T. 14, R. 8 E., in Calhoun county, sampled from a stock-pile at Tecumseh. The bank belongs to the Tecumseh Iron Company, though other parties own ore-banks in the same section. The analysis of this sample shows— d

	256.
	Per cent.
Metallic iron	50.64
Phosphorus	0.541
Phosphorus in 100 parts iron	1.331

This ore shows many pots lined with purple clay, and having dense brown walls; its associated clay is a bright yellow.

The ore from the Terry bank shows the following composition upon complete analysis— e

	252.		252.
	Per cent.		*Per cent.*
Sulphur	0.179	Carbon in carbonaceous matter	0.25
Phosphorus	0.108	Hygroscopic water	0.42
Iron, metallic	50.04	Water of composition	10.20
		Total	99.923
Silica	11.28		
Iron, protoxide	0.22	Per cent of insoluble silicious matter	15.14
Iron, peroxide	71.15		
Alumina	4.99	Silica	11.23
Lime	0.25	Alumina (with trace of oxide of iron)	3.30
Magnesia	0.25	Lime	0.15
Iron, disulphide	0.337	Magnesia	0.16
Potassa	0.14	Potassa	0.14
Soda	0.11	Soda	0.11
Carbonic acid	0.13		
Phosphoric acid	0.246	Total	15.09

f

After passing Tecumseh furnace the Selma, Rome, and Dalton railroad crosses the Georgia line 1 mile east. The range of limonites continues into that state, and trends away in a northeast direction. Samples 448 and 449, from the Pennington and Alloway banks on the Ætna furnace property, in Polk county, Georgia, are described in the report on the Georgia ores, by Mr. Bailey Willis, and lie 1 mile from the Alabama state line.

a The *Rock Run* furnace, which has been idle for some years, is situated in Sec. 5, T. 12, R. 11 E., Cherokee county. The "Furnace" bank, occupying the sides and crown of the hill at the furnace, has been worked in a number of places. The old pits are much fallen, affording but a poor opportunity for sampling. Sample 258 was taken from three pits on this bank, and shows, upon analysis, the following result:

b

	258.
	Per cent.
Metallic iron	54.96
Phosphorus	0.342
Phosphorus in 100 parts iron	0.622

The ore is a hard, dense, brown limonite.

The *Hardin* bank, situated in Sec. 32, T. 11, R. 11 E., has been recently opened, and is one of the furnace banks. The sample was taken from a small opening showing the ore in lumps and irregular masses in red clay, not sufficiently developed to show its probable extent. Sample 257 was here taken, and gives, upon analysis—

c

	257.
	Per cent.
Metallic iron	54.15
Phosphorus	0.749
Phosphórus in 100 parts iron	1.383

This sample was from surface lumps, and completes the list of limonites taken on this range of ores. From these ores the celebrated car-wheel iron of Alabama is manufactured.

FOSSIL ORES.

The fossil or dyestone ore of the main Red Mountain group will next be considered. The ore is a soft red hematite of a distinctly granular structure, cleaving readily into thin slabs of varying thickness, and when so cleft d showing thickly bedded fossils upon the cleavage surfaces. These fossil forms are more distinct in the softer and more or less decomposed varieties of the ore. The ore stains the hand a deep red, and has an unctuous feeling when rubbed between the fingers. It lies in a well-defined bed, capped in most instances by a heavy layer of sandstone. The outcrop on that portion of the range south of Springville, in Saint Clair county, is to be found near the crown of the northeast slope of the ridges, dipping southeast. North of Springville the beds, which are three or more in number, dip northwest, and the range is much broken and divided.

The most southerly outcrop of fossil ore seen was that on the *Shamblin and Dickey* tract, in Tuscaloosa county, in the SE. ¼ Sec. 34, T. 20, R. 6 W. Here, on the crown of a low hill, a test-pit had been sunk 9 feet upon the outcrop, and from the lumps of ore thrown out the sample was taken. The pit had long since fallen in, preventing the bed e from being seen. This ore is to be opened for use of the Alice furnace, in Birmingham, and shows, upon analysis—

	227.
	Per cent.
Metallic iron	49.49
Phosphorus	0.048
Phosphorus in 100 parts iron	0.097

This bed seems isolated, though it belongs with the Red Mountain group, which it resembles both in texture and in composition.

f In the southern part of Jefferson county, in Sec. 11, T. 19, R. 4 W., the bed of fossil ore is exposed 13 feet in thickness on the property of Mr. *M. L. Potter* and Mr. J. N. A. Griswold, of New York. Here, in the northwestern quarter of Sec. 11, T. 19, R. 4 W., a small prospecting pit has been opened, exposing the whole thickness of the bed. Sample 260 was taken from top to bottom and across the exposed face, and gives an average of the vein. The analysis of this sample, which was taken at pit No. 1, shows—

	260.
	Per cent.
Metallic iron	54.15
Phosphorus	0.152
Phosphorus in 100 parts iron	0.281

Sample 261 is from SE. ¼ Sec. 2, T. 19, R. 4 W., on the same property. The whole thickness of the bed, here a 13 feet 8 inches, is divided into three seams by 1 foot 8 inches of hard ore lying between the upper and lower softer portions. From this hard portion the sample in question was taken, yielding, upon analysis—

	261.
	Per cent.
Metallic iron	40.04
Phosphorus	0.319
Phosphorus in 100 parts iron	0.797

b

Continuing northward along the crown of Red mountain, the ore is found outcropping in a rough ledge toward the west. This outcrop is of a hard, rather dense ore, but farther back from the steep western face of the ridge an overlying softer seam can be traced. The outcropping seams, both hard and soft, were sampled along a quarter of a mile, with the strike in SE. ¼ Sec. 30, T. 18, R. 3 W. This ore is to be opened in the fall of 1880 for the use of the Alice furnace now building in Birmingham, Jefferson county. This ore shows, upon analysis—

	204.
	Per cent.
Metallic iron	56.69
Phosphorus	0.067
Phosphorus in 100 parts iron	0.118

c

This sample, it must be borne in mind, comes from a much weathered outcrop, and is no indication of the ore deeper upon the vein, which is apt to be lower in iron and to contain more phosphoric acid.

The *Eureka* mine is situated on the very crown of Red mountain in the NE. ¼ Sec. 21, T. 18, R. 3 W., Jefferson county. The mine is opened on the outcrop, and is worked by tunneling along the strike of the bed, which is here 7 feet thick and divided into two seams—an upper 4 feet of soft ore, and a lower 3 feet of harder ore. These two seams are mixed in mining, but a separate sample was taken from each with a view of determining their d difference. The samples were both from about 20 or 30 feet from the outcropping edge of the bed at the side of the upper tunnel. The following analyses show the difference in the ores:

	202.	203.
	Per cent.	*Per cent.*
Metallic iron	51.25	50.40
Phosphorus	0.219	0.519
Phosphorus in 100 parts iron	0.426	1.030

e

This difference is very striking and shows the value of separating the upper seam from the more phosphatic lower one (see full analysis). The bed is overlain by sandstone, and dips southeast with the formation. This ore is sent to the Oxmoor furnaces, on the line of the Alabama North and South railroad, to which it is conveyed by a narrow-gauge railway, running a small engine. The Oxmoor furnaces are situated between Secs. 33 and 34, T. 18, R. 3 W., Jefferson county. Sample 202 yields, upon full analysis—

	202.		202.
	Per cent.		*Per cent.*
Sulphur	0.139	Phosphoric acid	0.501
Phosphorus	0.219	Carbon in carbonaceous matter	0.02
Iron, metallic	51.25	Water of composition	2.17
		Total	100.071
Silica	16.59		
Iron, protoxide	0.19	Per cent. of insoluble silicious matter	19.28
Iron, peroxide	72.84		
Alumina	6.57	Silica	16.59
Manganese, protoxide	0.37	Alumina	2.52
Lime	0.27	Lime	0.12
Magnesia	0.22	Magnesia	0.07
Iron, disulphide	0.260		
Carbonic acid	0.07	Total	19.30

f

a The ore from the two seams at Eureka mine was sampled from the stock-pile at Oxmoor, and yields upon analysis—

	205.
	Per cent.
Metallic iron	50.89
Phosphorus	0.225
Phosphorus in 100 parts iron	0.442

The ore from Eureka mine in Tuscaloosa county, shown in sample 230, was again sampled here, and yielded b upon analysis—

	206.
	Per cent.
Metallic iron	44.12
Phosphorus	0.259
Phosphorus in 100 parts iron	0.587

This sample was from a stock-pile of 100 tons.

c The burnt blackband ores from Newcastle were also sampled at the Oxmoor piles, but will be quoted under the description of these ores at the end of this paper.

On the crown of the ridge east of Birmingham, in Jefferson county, in the SW. ¼ Sec. 6, T. 18, R. 2 W, the dyestone ore has been opened by a small pit sunk some 20 feet upon the vein which dips southeast, and is capped by a layer of sandstone. The ore was opened for the use of the Alice furnace in Birmingham, and shows, upon analysis—

d

	201.
	Per cent.
Metallic iron	46.80
Phosphorus	0.200
Phosphorus in 100 parts iron	0.429

The old *Irondale furnace*, now abandoned, is situated on the eastern side of Red mountain, 5 miles east of Birmingham, in Jefferson county. The mine is situated in a ravine on the east slope of Red mountain, 1 mile west of the furnace, and was worked by means of several tunnels running with the strike of the bed which dips southeast. The tunnel entrances are completely fallen, so as to prevent approach to the old working-faces; the sample was therefore taken from a pile of a few tons exposed for some ten years at the mouth of the opening. The ore is dense and rather sandy in character, and shows, upon analysis—

e

	222.
	Per cent.
Metallic iron	36.41
Phosphorus	0.161
Phosphorus in 100 parts iron	0.442

The ore is capped by a coarse sandstone, above which, and farther up the ravine, lies a limestone once used for a flux in the furnace. This mine was one of the first openings upon Red mountain dyestone ores. In T. 16, R. 1 W., 2 miles west of Trussville, on the Alabama and Chattanooga railroad, in Jefferson county, the outcrop of fossil ore is found on the Hickman place, and this portion of the mountain has recently been purchased for mining f purposes. In the NE. ¼ of SE. ¼ Sec. 10, T. 16, R. 1 W., a small opening had been made upon the ore-bed some three feet in depth and as many across. The bed is here 4 feet in thickness, dipping southeast, the upper 1 foot consisting of a softer, somewhat decomposed ore. The sample was taken from both upper and lower seams, and about 2 feet from the original outcrop face. The analysis shows—

	213.
	Per cent.
Metallic iron	59.99
Phosphorus	0.085
Phosphorus in 100 parts iron	0.142

Fifty feet below this bed is a second bed composed of highly ferruginous limestone, having the general a appearance of the fossil ore, but without the defined fossil forms. It is much harder than the ore and of a more crystalline structure. It was thought possible that this bed might prove of value as a flux, but the high per cent. of phosphorus ruins it for such a purpose. The analysis shows—

	214.
	Per cent.
Metallic iron	18.18
Phosphorus	0.102
Phosphorus in 100 parts iron	0.561

b

This bed dips southeast with the ore-bed. The outcrop is largely exposed in NE. ¼ of NE. ¼, Sec. 15, T. 16, R. 1 W., where on the two sides of the Jasper road a sample was taken. This ore is also on the Hickman place, and gives, upon analysis—

	215.
	Per cent.
Metallic iron	44.16
Phosphorus	0.051
Phosphorus in 100 parts iron	0.115

c

This ore was quite hard; its thickness was not exposed.

Continuing north along Red mountain, a small opening is found in the SW. ¼ Sec. 28, T. 14, R. 2 E., Saint Clair county. A short tunnel has here been run along the strike of the ore-bed. Here the softer portion of the seam is near the bottom, the whole bed being only 36 inches thick. This pit is one of the *Woodall* openings, and is abandoned. The analysis of sample taken across the whole bed gives—

	216.
	Per cent.
Metallic iron	48.68
Phosphorus	0.292
Phosphorus in 100 parts iron	0.600

d

On the mountain range northwest of Springville, in Saint Clair county, on the property of Mr. *A. W. Woodall*, large quantities of ore are being mined. The beds outcropping on the northeast slope of the ridges are worked by stripping along the strike. This method of mining is followed with a view to securing only the softest ore, which is most easily mined. No depth upon the bed had been reached when the mines were visited. The upper seam at this point is about 50 feet below the crown of the ridge and dips northwest, about 3½ feet of its thickness being exposed. The analysis of a sample taken along 30 feet of the outcropping bed shows— e

	217.
	Per cent.
Metallic iron	53.28
Phosphorus	0.261
Phosphorus in 100 parts iron	0.490

One hundred and ten feet below this upper bed is a second one, also outcroping on the northeast slope. This bed is opened for some hundred feet along the outcrop. The sample here taken shows upon analysis:

f

	218.
	Per cent.
Metallic iron	49.49
Phosphorus	0.435
Phosphorus in 100 parts iron	0.879

These two samples were taken from the SW. ¼, Sec. 27, T. 14, R. 2 E., in Saint Clair county.

Four miles northeast of Springville, on the land of Mr. *A. D. Aderholt*, an opening has been made upon the Red Mountain ore in Sec. 23, T. 14, R. 2 E., Saint Clair county. The bed was here opened by a cut which exposes the seam dipping northwest, and varying in thickness from 30 inches to 3 feet. This bed at the outcrop, and for

a some 30 feet running with the dip, is of a dark-red color, and shows a compact, fossil ore. Thirty feet upon the dip there seems to be a slight fault, beyond which, continuing down the dip, the bed changes to a compact, bluish limestone, in which however traces of fossils can still be seen. (See Fig. 159.)

b

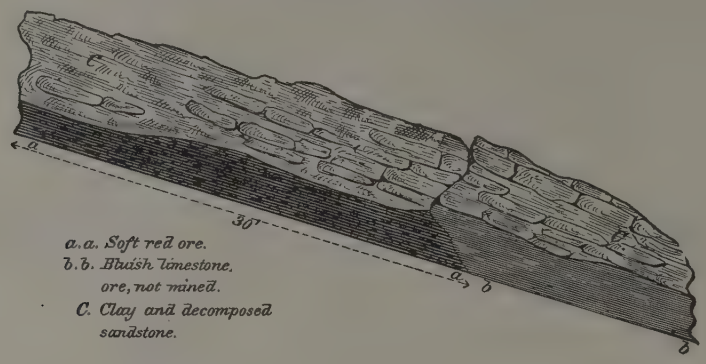


FIG. 159.—SECTION ON LAND OF A. D. ADERHOLT, ALABAMA.

c This limestone is similar to that sampled on the Hickman place, described above under sample 214. The softening of the upper part of the ore-bed is here due to the infiltration of surface-waters to which the harder limestone portion at a greater depth has not been subjected. This suggests at once the origin of the fossil ores, and points to the probable nature of the Red mountain beds when a greater depth shall have been reached, and those portions which have not been subjected to the leaching of surface-waters are exposed.

This sample was taken above the fault in the bed, and wholly from the soft part of the bed, and shows, upon analysis—

d

	219.
	Per cent.
Metallic iron	45.45
Phosphorus	0.409
Phosphorus in 100 parts iron	0.900

A second sample, drawn from the same mine, was taken on the stock-pile on the Alabama and Chattanooga railroad, 1 mile from the mine, and shows, upon analysis—

e

	220.
	Per cent.
Metallic iron	48.40
Phosphorus	0.348
Phosphorus in 100 parts iron	0.719

These ores, as well as the ores from Mr. Woodall's mine, were being shipped to the South Pittsburg furnaces, Marion county, Tennessee.

Other points on the Red mountain above Springville are to be opened for mining purposes. Wilson's mine, in Sec. 23, T. 14, R. 2 E.; the Thomason and Goodwin mine, in Secs. 12 and 13, T. 14, R. 2 E.

The openings on the fossil ore on the range, 1 mile west of Attala, in Etowah county, are known as the *Attala* mines. Here the ore is worked both by stripping along the outcrop and by tunneling.

In Sec. 34, T. 11, R. 5 E., on the property of Mr. John Moragne, a tunnel had been pushed on the crown of the f vein, and had entered across the angle of dip some 30 feet upon the bed. From this depth the sample was drawn from the working-face. The ore is soft and crumbling, and contains few hard lumps. This mine is worked for the Rising Fawn furnace, in Dade county, Georgia, and is known as the *Rising Fawn* mine. A second sample (268) of the same ore was taken from a stock-pile of 150 tons at Attala. These two samples give, upon analysis—

	265.	268.
	Per cent.	*Per cent.*
Metallic iron	54.48	56.04
Phosphorus	0.640	0.430
Phosphorus in 100 parts iron	1.174	0.767

This shows an important difference, and is to be accounted for by the fact that the ore in the stock-pile was a taken from much nearer the outcrop, and had been some months in the pile, and, as above shown, the outcrop is likely to show lower phosphorus than ore deeper from the surface. To illustrate this further, a sample was taken from a second stock-pile at Attala, representing only the "crop-ore" taken by stripping along the exposed bed. This sample shows, upon analysis—

	266.
	Per cent.
Metallic iron	53.78
Phosphorus	0.487
Phosphorus in 100 parts iron	0.906

b

Farther northeast upon the mountain, in the same section, the vein has again been opened, on property leased by the South Pittsburg Iron Company, Marion county, Tennessee. An incline here enters upon the bed, and, when visited, had reached a depth of 30 to 40 feet. At this depth the mining was stopped, on account of the hardening of the ore, which changes to the same dense bluish limestone shown at the Springville mines. The sample was taken from the soft portion of the ore, and shows, upon analysis—

	267.
	Per cent.
Metallic iron	53.60
Phosphorus	0.641
Phosphorus in 100 parts iron	1.197

c

The bed of fossil ore at this point is much disturbed. Dipping to the northwest at the Rising Fawn mine, it then becomes vertical as it runs north along the crown of the western slope to the South Pittsburgh property, where it dips to the southeast.

Two samples of ore from the property of Rathburn, Foster & Winchester, on Sec. 34, T. 11, R. 5. E., were collected at the South Pittsburg furnaces. Sample 270 represents a soft porous ore, and 271 a dense, hard, crystalline ore. The samples contained: d

	270.	271.
	Per cent.	*Per cent.*
Metallic iron	45.98	31.30
Phosphorus	0.412	0.375
Phosphorus in 100 parts iron	0.896	1.198

Sample 267 has been subjected to complete analysis, and gives the following result:

e

	267.
	Per cent.
Sulphur	0.085
Phosphorus	0.641
Iron, metallic	53.60
Silica	10.52
Iron, protoxide	0.46
Iron, peroxide	75.99
Alumina	5.58
Manganese, protoxide	0.23
Lime	2.23
Magnesia	0.52
Iron, disulphide	0.124
Potassa	0.17
Soda	0.01
Carbonic acid	0.09
Sulphuric acid	0.05
Phosphoric acid	1.469
Carbon in carbonaceous matter	0.04
Hygroscopic water	1.02
Water of composition	0.69
Total	100.193

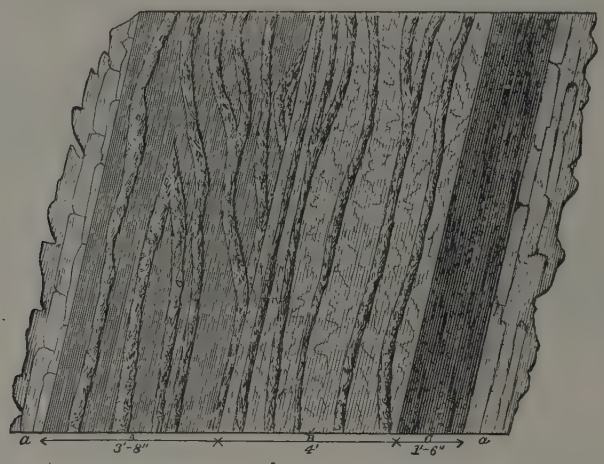
	267.
	Per cent.
Per cent. of insoluble silicious matter	13.31
Silica	10.52
Alumina	2.35
Lime	0.65
Magnesia	0.20
Potassa	0.17
Soda	0.01
Total	13.30

f

Some few openings of small importance have been made upon the dyestone bed, between Attala and the Georgia line, on the Alabama and Chattanooga railroad, which follows the eastern base of Red mountain, but only a few tons have been taken.

a In Sec. 30, T. 15, R. 1 W., in the northern part of Jefferson county, on that portion of the dyestone range known as Little Red mountain, two outcrops of ore were sampled, the first at *Massey's mill*, on Turkey creek, where the ore-bed was exposed by the mill-race. The vein, which was here almost vertical, is shown in the accompanying cut.

b



c

A. Gray slate with thin seams of fossil ore.
B. Yellow clay with thin seams of fossil ore.
C. Seam of fossil ore.
D. [illegible] and decomposed sandstone.

FIG. 160.—SECTION NEAR MASSEY'S MILL, JEFFERSON COUNTY, ALABAMA.

The running water in the mill-race made this face inaccessible, and the measurements are only approximate. The sample was taken from lumps of ore thrown out in digging the race, and shows, upon analysis—

d

	210.
	Per cent.
Metallic iron	36.58
Phosphorus	0.324
Phosphorus in 100 parts iron	0.886

The bed was again sampled on Mr. Rodgers' land, 1 mile farther down the creek, from an outcrop 50 yards from the county-road crossing. This is a hard, lean ore, showing, upon analysis—

e

	211.
	Per cent.
Metallic iron	28.22
Phosphorus	0.061
Phosphorus in 100 parts iron	0.216

The *Round Mountain furnace* is situated in Sec. 33, T. 9, R 9 E., in Cherokee county, on the side of a steep hill, in which its ore-bed is located. The ore is a red fossil ore, occurring in a well-defined vein and mined in open pits and trenches. Three samples were here taken, which show, upon analysis—

f

	262.	263.	264.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	59.0	58.39	57.18
Phosphorus	0.084	0.104	0.098
Phosphorus in 100 parts iron	0.142	0.178	0.171

No. 262 is an average sample taken from the stock-pile at the furnace. No. 263 is from an old pile of some few tons of roasted ore left at the furnace top some six years previous. No. 264 was taken from four pits on the bank 50 feet apart. This ore was being piled for roasting. The furnace is now in the hands of the Round Mountain Coal and Iron Company.

CARBONIFEROUS LIMONITES.

The limonites of the Carboniferous age were sampled at only two points. The first from Jefferson county, a Sec. 25, T. 17, R. 1 W., where the ore was once dug for a Catalan forge on a near branch of Cahaba river. The crown of a small hill was covered with pits for the space of an acre, and the sample was drawn from such loose lumps as could be found, giving, upon analysis—

	221.
	Per cent.
Metallic iron	52.30
Phosphorus	0.057
Phosphorus in 100 parts iron	0.109

b

A second sample was taken from loose lumps scattered over the surface of a low hill in the SE. ¼ of Sec. 9, T. 16, R. 1 W., in Jefferson county, and yields upon analysis—

	212.
	Per cent.
Metallic iron	51.94
Phosphorus	0.301
Phosphorus in 100 parts iron	0.580

c

These ores occur in loose, sandy, light-colored clay, associated with much white and yellow chert, and are very irregular in deposit.

BLACK-BAND ORES.

The black-band iron ores, as has been stated, are mined at only one locality in the state, on the land of the Newcastle Coal and Iron Company, at Newcastle station on the North and South Alabama railroad, in the SW. ¼ of the NE. ¼ of Sec. 17, T. 16 S., R. 2 W. The ore is reached by means of a tunnel running with the strike of the bed, which dips northwest. The accompanying cut shows a section, with the strike of the beds, taken on the southeast wall of the farther end of the tunnel:

d

e

1. Black slate.
2. Gray shale.
3. Black slate.
4. Black band ore, 1 inch.
5. Brown shale.
6 Black band ore.

FIG. 161.—SECTION NEAR NEW CASTLE STATION, JEFFERSON COUNTY, ALABAMA.

Sample 209 was taken from the lower 12 inch seam, the only one worked on the ore proper, though some attempt was being made to render the dark shale above it valuable by burning. Sample 208 was taken from the 7-inch seam of brown shale. Sample 207 was taken from the stock-pile of roasted ore at Oxmoor furnace from a 12-inch seam. These three samples give, upon analysis— f

	207.	208.	209.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	43.49	8.38	29.48
Phosphorus	0.228	0.115	0.194
Phosphorus in 100 parts iron	0.524	1.372	0.658

Besides the above-enumerated ores there are many deposits, mentioned in the geological reports of Alabama which have not as yet been either located or examined with a view to mining.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN ALABAMA.

By Bailey Willis.

c The following notes on a few of the Alabama iron ores were taken during a short visit to the state in April, 1881. The previous report by Mr. W. M. Chauvenet contains the description of all those deposits it was at first intended to take notice of. Those herein described are nearly all known only by their outcrops, and are as yet of but little commercial importance. In addition to these, there are the limonites of the sub-Carboniferous along the Coosa river, a number of outcrops of limonite in the great Lower Silurian limestone belt, and some outcrops of magnetic ore in the metamorphic rocks. These could not be examined on account of the more important work to be completed in other states.

The following are the iron ores herein reported upon: Limonite, on the farm of Mr. J. H. Pendergrass, near Davisville, Calhoun county; magnetic ore, on the farm of Mr. J. M. Kennedy, near Delta, Clay county; limonite, near Russelville, Franklin county; limonite, near Vernon, in Lamar county.

d Davisville lies in a valley of Lower Silurian limestone, between the slates of the Metamorphic group on the east and a ridge of Potsdam sandstone that rises to a height of 200 feet on the west. The little village itself stands on a limonite bed, which has been penetrated to a depth of 60 feet in wells. A mile farther north is the farm of Mr. *Pendergrass*. In the meadows west of his house the ore crops out in place, forming little knolls, and surface pieces are thickly scattered over the eastern slope of the ridge almost to the summit, where the Potsdam sandstone appears. Two samples were taken on Mr. Pendergrass' property—one from the pieces on the ridge, the other from the outcrops in the meadows. The analyses give—

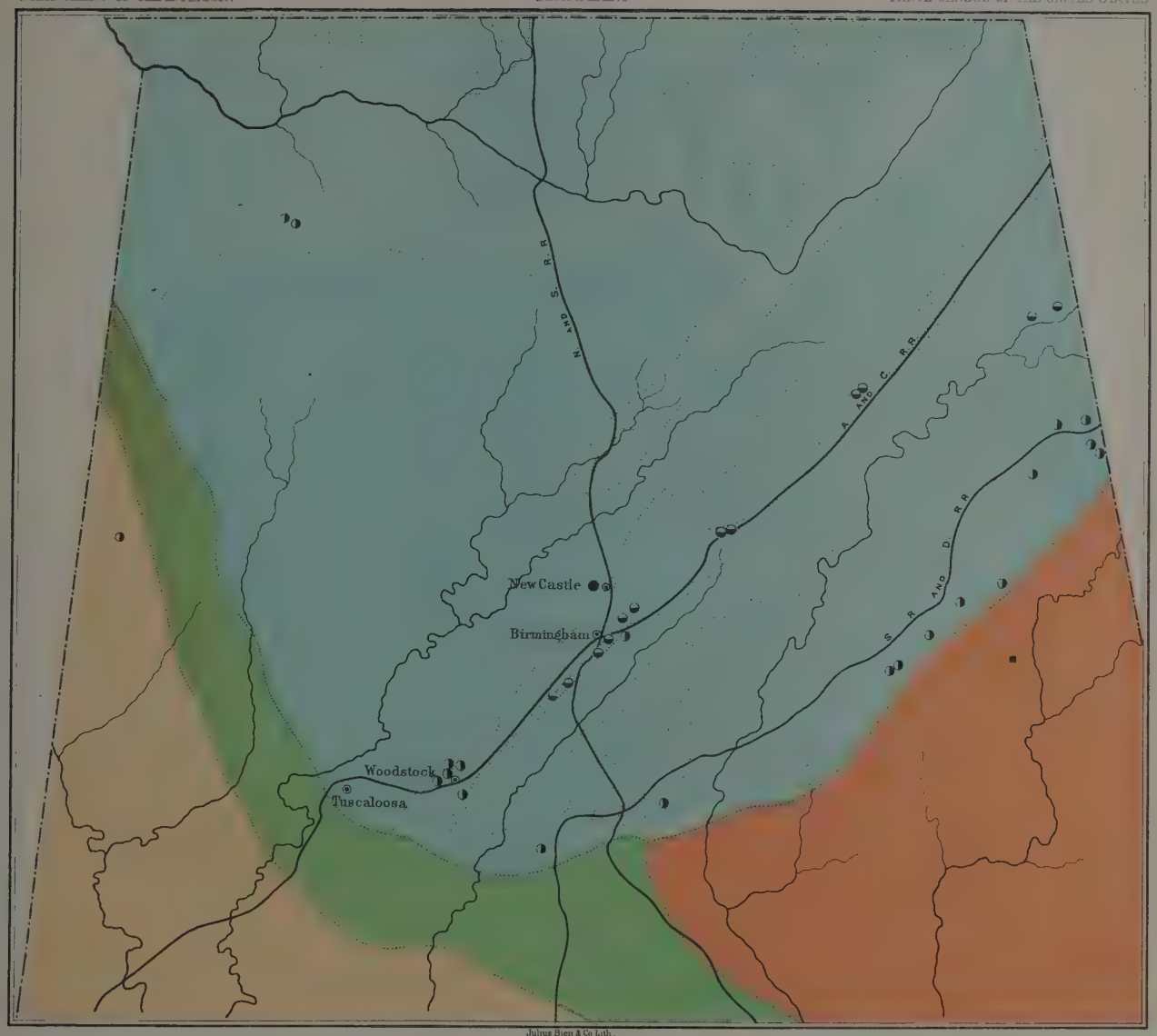
e

	RIDGE.	MEADOW.
	1201.	1202.
	Per cent.	*Per cent.*
Metallic iron	58.29	54.86
Phosphorus	0.423	0.184
Phosphorus in 100 parts iron	0.726	0.335

These ores are now 12 miles from the nearest railroad at Oxford; but it is claimed that the projected railroad from Atlanta, Ga., to Birmingham will pass through Davisville, in which case they will be immediately on the line of transportation.

f There are a number of localities in eastern Alabama and central Georgia whence specimens of magnetic ore have been received. They are all granular, more or less silicious, weathered fragments. Their appearance leads to the inference, which all reports confirm, that these are small surface pieces found lying loose in the ground. So far as is known to the writer, no ore has been found in place in these localities.

Professor E. A. Smith, state geologist, pointed out the farm of Mr. *J. M. Kennedy*, in the northeastern corner of Clay county, as the most promising point of occurrence of this ore. It was visited by the writer. Loose pieces of a distinctly-stratified, very silicious, magnetic schist are thickly scattered in a narrow belt, having a general northeast southwest course in a level plowed field. Layers of coarsely-granular magnetite, from one-quarter to 3 inches thick, are inclosed between similar layers of much leaner ore, or even pure-white crystalline quartz. Some of the ore is much finer-grained, and is slightly altered to martite. No specimen of pure magnetite more than 3 inches thick was found.



Julius Bien & Co. Lith.

IRON ORE SAMPLE MAP OF ALABAMA.

Geology from Geological Map of Alabama by Eugene A. Smith, 1878.

Drift. Cretaceous. Coal Measures. Sub-Carboniferous. Silurian & Devonian. Metamorphic.

◑ Limonite. ◒ Fossil. ● Black Band. ■ Magnetite

Scale: 25 miles = 1 inch.

The following is the analysis of the sample taken from the surface-pieces. It is probably richer than the a average of the ore, if taken out in large quantities, while it would be easy to pick out individual specimens much richer than this sample:

	1203.
	Per cent.
Metallic iron	58.51
Phosphorus	0.064
Phosphorus in 100 parts iron	0.109

b

In the geological map of Alabama all the northwestern corner of the state is colored for the sub-Carboniferous limestone.

Professor Smith himself pointed out, however, that a high ridge which extends east and west and is crossed by the road from Tuscumbia to Russelville is probably formed by the sandstones and shales at the bottom of the Coal Measures. The underlying limestones form the valley in which Russelville lies, and there, as throughout western Tennessee, are associated with limonite. West of Russelville a small creek flows north and south. Upon the gentle slopes either side of this creek pieces of limonite are so thickly and so widely scattered as to give the impression of very large deposits beneath the surface. That deposits of very considerable extent exist here is certain; but they are probably very superficial, and the amount of ore to the acre is likely to be comparatively small. c

Two samples were taken from a large number of surface-pieces, one from the lands of Mr. *T. B. Fleming*, Sec. 28, T. 6, R. 11 W.; the other from the property of Dr. *Sevier* Sec. 29, T. 6, R. 11 W:

	T. B. FLEMING.	DR. SEVIER.
	1204.	1205.
	Per cent.	*Per cent.*
Metallic iron	55.60	56.89
Phosphorus	0.590	0.527
Phosphorus in 100 parts iron	1.061	0.926

d

Two miles west of Vernon, in Lamar, formerly Sandford, county is an old furnace which used a limonite ore dug in the hill immediately adjacent to the furnace. This hill and one half a mile southwest of it are the highest in the neighborhood; they rise, perhaps, a hundred feet above the valley. They are formed of the red clay and pebble beds peculiar to the drift formation in the southern states. Above these is a horizontal bed of bog-iron ore 3 to 6 feet thick, and the summit is formed of red soil 8 to 10 feet in depth. The surrounding hills are all too low to catch the bed of ore, but it is said to occur in elevations 3½ miles south and 4 to 5 miles northeast on Yellow creek. The ore very closely resembles in its open texture bright luster, and in the inclosure of woody fragments the bog-ores of eastern North Carolina. e

Two samples were taken—one from pieces of raw ore found in the old pits near the summit of the hill, the other from a mass of roasted, much-agglomerated ore.

	RAW ORE.	ROASTED ORE.
	1206.	1207.
	Per cent.	*Per cent.*
Metallic iron	55.04	62.65
Phosphorus	0.191	0.265
Phosphorus in 100 parts iron	0.347	0.423

f

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN MISSOURI.

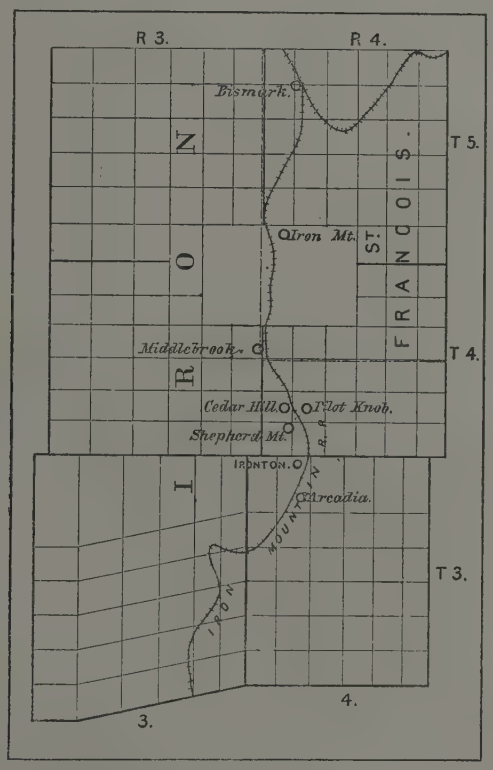
By W. M. Chauvenet.

It is the purpose of this paper to describe only the opened and working deposits of ore in the state. The extensive deposits of limonite so widely scattered throughout the region as yet remain untouched for mining purposes, though for the most part located by the several geological surveys. Samples taken from surface-lumps c on unopened banks of limonite are unsatisfactory, and the analyses of such samples seldom give an idea of the deposit as a whole, and are therefore only misleading. The samples taken were therefore entirely from the specular ores and the soft hematites of southeast and central Missouri, which are at present the only ores in use.

Specular ores in porphyry (Archæan).

Iron mountain, situated in Saint François county, Sec. 31, T. 35, R. 4 E., is the largest deposit of ore of any kind yet discovered in Missouri.

d



e

f

Fig. 162.—Iron mountain, Pilot knob and vicinity.

For an external description of the mountain, see report of Dr. A. Litton (p. 75, *Second Annual Report of Missouri*, G. C. Swallow). For a geological description of the region, see *Geological Survey of Missouri*, R. Pumpelly, 1872, Part I, pp. 10 and 99.

a. Fig. 163 is an outline sketch of the mountain, showing the present openings upon the ore. The cuts A, B, C, D, E, shown in the volume of 1872 (chap. V, p. 100), now constitute one large opening on the crown, shown at I (Fig. 163).

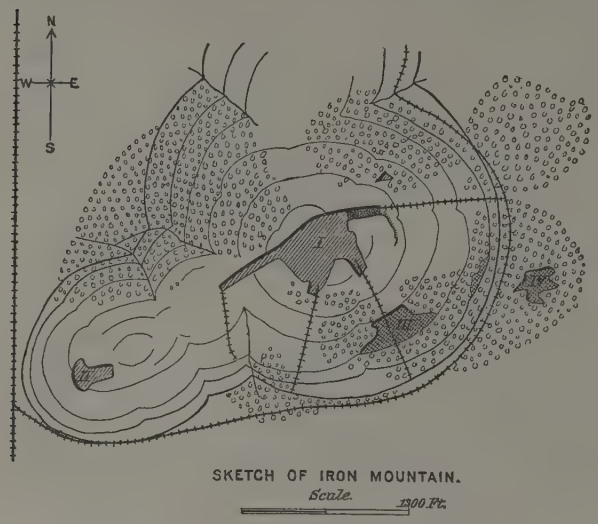


FIG. 163.

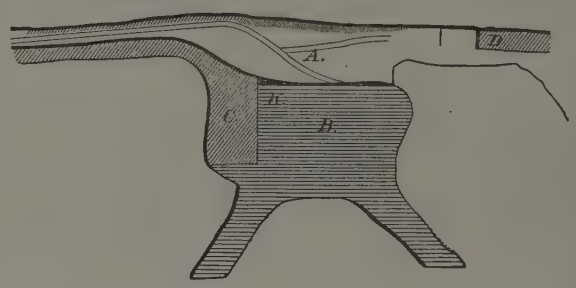


FIG. 164.—PLAN OF MAIN PIT, IRON MOUNTAIN, MISSOURI.

This cut is worked in three levels or benches, A, B, C (Fig. 164), which change their relative shapes and dimensions as the veins of ore vary and are followed.

A is the upper level, B the second, and C the third. At II, on the southwest spur, the vein is worked in five benches, descending in steps of 10 to 15 feet to a depth of 80 feet, all attacking the same lead of ore. The pit now collects much water, and constant pumping is necessary. The surface ore is at present principally worked on **d** the southeast slope of the mountain, at III and IV, Fig. 163.

The vein ore of Iron mountain is a massive blue specular ore, having a metallic luster, a more or less crystalline structure, at times highly crystalline, and a hardness of about 6. Its fracture shows a bright steely surface, and the streak is of a cherry red, often of a rich purple color. It is more or less magnetic, the pure, highly crystalline varieties showing at times strong attraction and distinct polarity, while other varieties act but faintly on the needle and show no polarity whatever. (*a*)

The ore is much contaminated in places by clear quartz in irregular masses, and by well-defined and thickly-scattered crystals of pink apatite, the latter being most common. Though these crystals of apatite are for the most part unaltered, in certain exposed portions of the veins they have completely decomposed, leaving the **e** impressions of their hexagonal prisms, which often give to the ore a honeycombed appearance. The apatite seems at the present time to be increasing at C (Fig. 164), as a greater depth is reached; but similar areas of impure ore containing crystals of apatite as thickly scattered, were seen at higher levels when the mountain was visited in 1877.

In the west cut (II, Fig. 163) beautiful specimens of ore were obtained, having much the appearance of an open-grained Bessemer pig-iron, filled with large, splendent, lamellar, crystals, and more coarsely crystalline than anyore elsewhere mined on the mountain.

The surface ore, the main distributions of which are shown in the figure, is similar to the vein ore in character, though it occurs in worn and rounded pebbles, scattered over the surface and through the surface clay to a depth in some places as great as 50 feet. It varies in size from boulders 2 feet in diameter to the finest sand, all of which is now being saved by the process of hydraulic mining and washing now in use.

f The following are the analyses of average samples of different varieties of the ore from Iron mountain:

	542.	543.	544.	545.	546.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	66. 93	59. 06	65. 57	64 67	62. 84
Phosphorus	0. 071	0. 398	0. 032	0. 019	0. 005
Phosphorus ratio	0. 106	0. 674	0. 049	0. 029	0. 008

No. 542 is a sample of No. 1 ore at K, level B (Fig. 164). Fine-grained variety free from apatite or quartz. No. 543 is the No. 2 ore from deepest level, C. It is a dense blue ore, thickly scattered, with crystals of apatite. No.

a The ore of Iron mountain is really martite, altered from magnetite.—*R. P.*

544. Surface ore, chestnut size, from C and D). No. 545. Finest of surface ore from the same cuts; taken from a sorted pile of 100 tons at the washer. No. 546. No. 1 ore; large, lamellar crystals; free from apatite or quartz; strongly magnetic; taken from the fourth level, from the top, at the west cut, II (Fig. 163). a

The mountain had yielded 2,258,922 tons of ore up to June, 1880.

Pilot Knob, in Iron county, Sec. 29, T. 34, R. 4 E., is a second great deposit of specular ore in porphyry (see description of Dr. A. Litton, *Second Annual Report of Missouri*, p. 79; also, *Missouri Geological Survey*, 1872, Part I, pp. 1, 109). Since the above reports were written the ore-bed has been extensively worked.

In the spring of 1879 underground work was commenced on the ore-bed, which was attacked at two points by tunnels running with the strike, the lower tunnel entering from the level of cut A, the upper tunnel from cut B (*Geological Survey of Missouri*, 1872, Part I, p. 110). b

Since no survey of the workings had been made at the time when visited no diagrams could be obtained; the excavations, however, are confined to the ore-bed proper, and the ore is worked in large rooms 50 feet square, separated by ribs or walls 20 feet thick for the purpose of support. The first room opening from the lower tunnel is 75 feet from the tunnel mouth. The ore-bed in this chamber is 25 feet in thickness, overlaid by a seam of slate 1 foot thick, which is taken out in mining the ore. The north wall of this room exposed a working-face 30 by 40 feet in solid ore. The lower 20 feet were composed of the finest ore on the knob, graded as No. 1. Sample 538 was taken on this face over an area 38 by 20 feet, all No. 1 ore.

This sample yields, upon full analysis, results as follows: c

	538.		538.
	Per cent.		*Per cent.*
Sulphur	0.020	Phosphoric acid	0.011
Phosphorus	0.005	Hygroscopic water	0.12
Iron, metallic	59.52	Water of composition	0.37
Phosphorus ratio	0.008	Total	100.311
Silica	12.17	Per cent. of insoluble silicious matter	13.78
Iron, protoxide	0.78		
Iron, peroxide	84.16	Silica	12.17
Alumina	2.21	Alumina	1.11
Lime	0.04	Lime	0.04
Baric oxide	0.10	Magnesia	0.04
Magnesia	0.04	Soda and potassa	0.22
Sulphuric acid	0.05	Barium, sulphate	0.15
Soda and potassa	0.22		
Carbonic acid	0.04	Total	13.73

d

The upper tunnel, on April 30, 1880, had reached a distance upon the ore of 260 feet, running with the strike; this tunnel, 10 feet in diameter, widens into three chambers of similar dimensions to those of the lower tunnel.

A sample was taken at the extreme end of the tunnel deepest upon the bed, from the driving-face, on a bench near the roof. The sample represents the ore directly beneath the slate-seam, and was taken over 50 square feet of surface.

This sample gives, upon analysis, results as follows: e

	539.		539.
	Per cent.		*Per cent.*
Sulphur	0.320	Carbon in carbonaceous matter	0.01
Phosphorus	0.018	Hygroscopic water	0.05
Iron, metallic	52.57	Water of composition	0.43
Phosphorus ratio	0.034	Total	100.071
Silica	18.71	Per cent. of insoluble silicious matter	23.74
Iron, protoxide	0.87		
Iron, peroxide	73.13		
Alumina	2.87	Silica	18.71
Lime	0.04	Alumina	2.19
Magnesia	0.06	Lime	0.04
Sulphuric acid	0.80	Magnesia	0.06
Barium oxide	0.51	Barium, sulphate	2.31
Carbonic acid	0.08	Soda and potassa	0.47
Phosphoric acid	0.041	Total	23.78
Soda and patassa	0.47		

f

The accompanying section (Fig. 165), taken from the *Missouri Geological Survey*, 1872, shows the exposure in what was formerly known as the "Big cut." Though no ore was mined above the slate-seam marked S, a selected sample was here taken from D, D, D. Though mostly composed of a dense and highly silicious porphyry, this often grades into good ore-masses, which may be distinguished by their higher metallic luster. From these seemingly good

a bunches of ore a sample was selected, avoiding the porphyry entirely, with a view to showing what might be saved from this upper bed by careful sorting. The sample so taken yields, upon analysis—

	540.
	Per cent.
Iron	50.40
Phosphorus	0.025
Phosphorus ratio	0.050

b

SECTION ON PILOT KNOB.

FIG. 165.

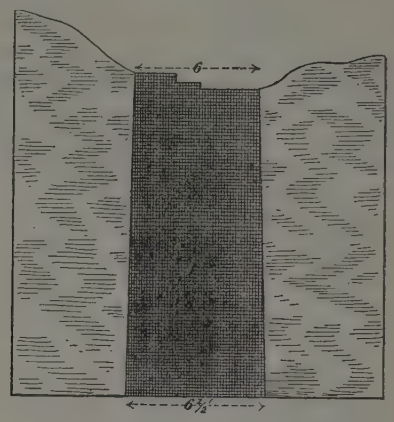


FIG. 166.—SECTION AT SHEPHERD MOUNTAIN, IRON COUNTY, MISSOURI.

c

(For a description of the ore, its qualities and appearance, see *Geological Survey of Missouri*, 1872, pp. 56–59.)

Shepherd mountain, situated in the NE. ¼ Sec. 31, T. 34, R. 4 E., in Iron county, 1 mile southwest of Pilot Knob, is the third great deposit of specular ore in porphyry of this region. In its general characteristics the deposit d much resembles Iron mountain, though the large deposit of surface-ore is wanting, and the porphyry is not so thoroughly decomposed. Two main cuts have been made on the ore, though the amount of ore taken has been comparatively small. The west cut has been recently reopened and some 700 tons taken out from a newly-exposed vein, a section across which is shown in Fig. 166.

This vein, which had been covered by an old dump-pile, strikes east and west where exposed, and rises between walls of yellow clay, showing no signs of porphyry or evidences of stratification. The ore of Shepherd mountain is of most excellent quality, and though sufficient work has not been done to determine its probable extent, the deposit is undoubtedly large.

The ore is very similar in appearance to that of Iron mountain, though in most instances the large splendent crystals resembling graphite are more common, and the streak is darker, varying from a rich dark purple to almost e black. It is further distinguished by numerous little cavities lined with minute crystals, or filled with a rich red oxide. A soft green chloritic mineral is also common, and the ore as a whole is softer and less brittle than that of Iron mountain. The ore is magnetic, different lumps showing different degrees of magnetism, and when powdered cling to the magnet more or less strongly. A sample was taken from a stock-pile at the cut, consisting of 700 tons of recently mied ore. It yields, upon complete analysis, results as follows:

f

	537.		537.
	Per cent.		*Per cent.*
Sulphur	0.077	Carbonic acid	0.09
Phosphorus	0.013	Phosphoric acid	0.029
Iron, metallic	65.39	Carbon in carbonaceous matter	0.01
Phosphorus ratio	0.020	Hygroscopic water	0.36
		Water of composition	1.00
Silica	3.18	Total	99.992
Iron, protoxide	1.76		
Iron, peroxide	91.36	Per cent. of insoluble silicious matter	4.27
Alumina	1.37		
Manganese, protoxide	Trace.	Silica	3.18
Lime	0.43	Alumina (with trace of oxide of iron)	0.87
Magnesia	0.10	Lime	0.06
Iron, disulphide	0.143	Potassa	0.11
Copper, sulphide	Trace.	Soda	0.05
Potassa	0.11		
Soda	0.05	Total	4.27

Cedar hill, half a mile directly north of Shepherd mountain, has been opened by a small test-pit on the west side near the crown, exposing an ore very similar to that of Pilot Knob. This pit was filled with water, and the sample was confined to 15 feet on the wall along the south side near the surface. The ore gives, upon analysis—

	541.
	Per cent.
Metallic iron	66.61
Phosphorus	0.006
Phosphorus ratio	0.009

Specular ores in sandstone (Lower Silurian).

The specular ores of central Missouri, and their accompanying hematites, occur in what is known as the "Second sandstone" (*Second Geological Report of Missouri*, p. 125), or in the chert associated with that bed. Throughout the central region, especially in Dent, Phelps, and Crawford counties, this second sandstone is greatly faulted and broken, and it is in the cavities and depressions thus formed that the specular ores occur. The deposits are usually either lenticular or funnel-shaped, and their extent is very uncertain, so much so indeed that it is quite impossible to estimate with any degree of accuracy the amount of ore in any one bank. This will be further illustrated in the descriptions that follow. The ores are of three kinds; their general characteristics may be described as follows:

1. The specular ore when freshly fractured is of a bluish-gray to a steel-gray color. It is dense in the mass, close-grained, more or less crystalline in structure, and has a hardness varying from $5\frac{1}{2}$ to $6\frac{1}{2}$. The fracture is

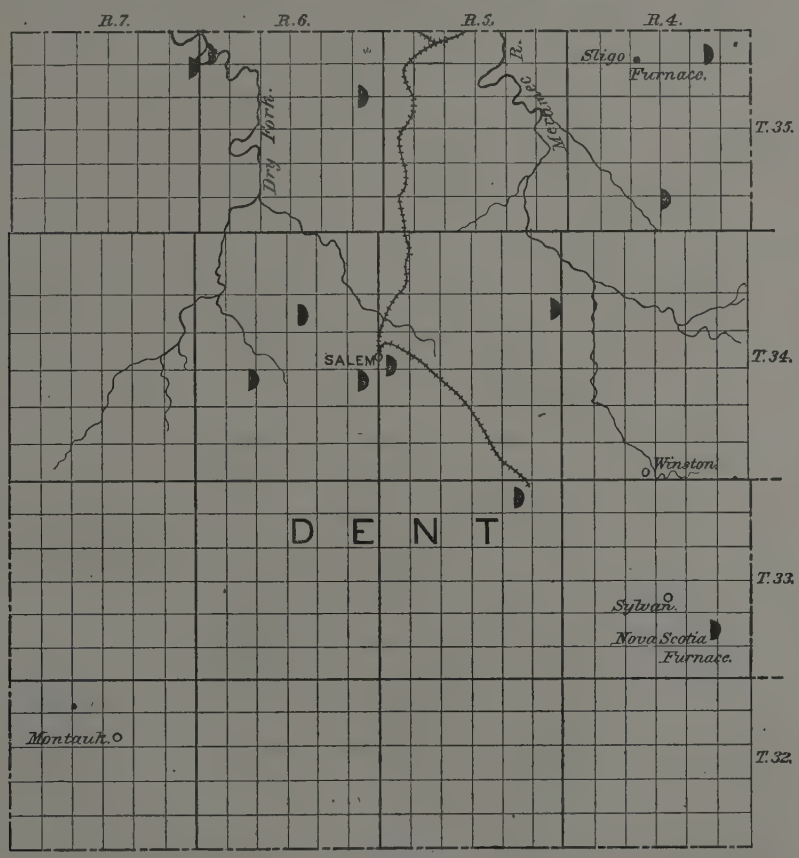


Fig. 167.—Map of Dent county, Missouri, showing banks of specular ore sampled.

brittle, and the fragments sharply angular. The ore is scattered throughout with minute cavities, lined in most instances with fine splendent crystals of hematite, but often with clear quartz and soft red oxide. These drusy cavities, though usually dull and velvety in luster, at times glow with the most brilliant prismatic colors. Yellow jasper is in places largely associated with the ore occuring in fine veins and irregular bunches in the mass, at times in such quantities as to render it unfit for use. Defined prisms of clear quartz are not uncommon.

2. The hard red hematite is the partly decomposed specular ore not yet reduced to a powder; it usually surrounds the specular ore, and occurs in broken lumps. It is of a deep-red or purple color, porous, and of a dull earthy luster and fracture. Remains of the original specular ore at times form a fine tracery through the mass, and occasional drusy cavities remain with their crystals still intact.

3. The soft hematite results from the thorough decomposition of the specular ore, and is associated with it and surrounds it in every degree of change. It occurs as a soft unctuous clay, usually of a rich purple color, leaving its stain freely upon all that it touches. When a surface is rubbed smooth with the hand it has a bright, almost metallic, luster, and a greasy feeling.

THE SALEM DISTRICT (DENT COUNTY).

Nova Scotia furnace, in process of erection, is situated in the NE. ¼ of the SE. ¼ Sec. 26, T. 33, R. 4 W. Its ore-bank occupies the crown and south slope of the hill directly north of the furnace, and has been located by a number

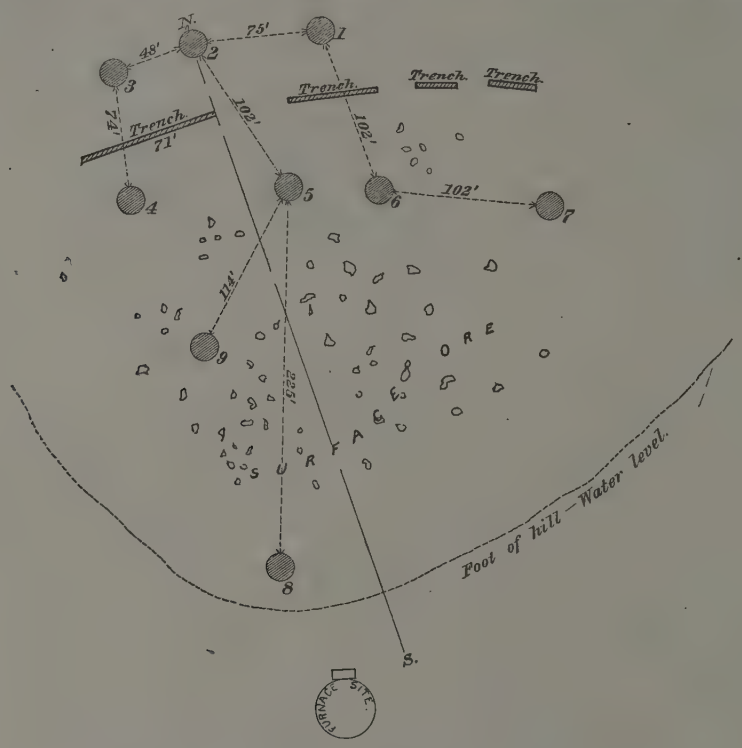
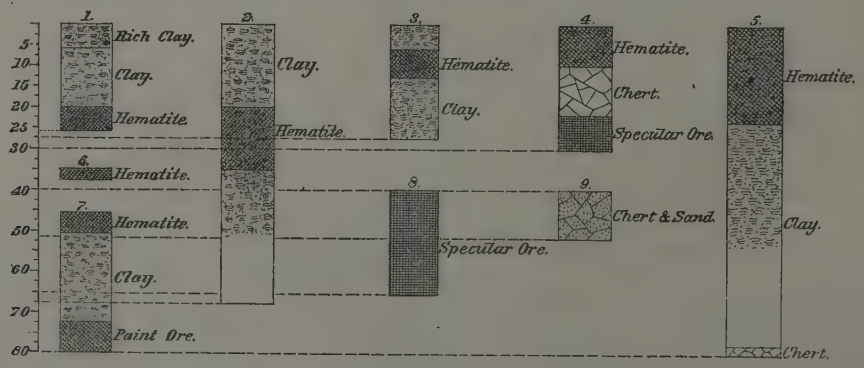


FIG. 168.—NOVA SCOTIA FURNACE AND VICINITY, DENT COUNTY, MISSOURI.

of vertical shafts, the positions of which are shown in Fig. 168. The sections exposed by these shafts are shown in Fig. 169. The deposit is one of specular ore in chert, and, as shown by the sections, is more or less changed to hematite in places.



NINE PITS ON NOVA SCOTIA BANK.—SECTIONS.

FIG. 169.

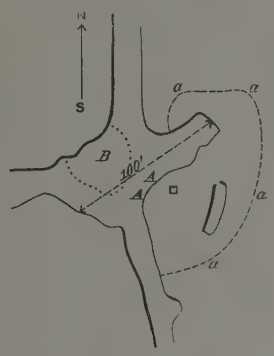
The surface of the hill, especially between pits 5 and 8, is thickly scattered with lumps of specular ore The a analyses of two samples taken give results as follows:

	563.	564.
	Per cent.	*Per cent.*
Metallic iron	63.77	67.02
Phosphorus	0.061	0.025
Phosphorus ratio	0.096	0.037

No. 563 is a hematite from pit No. 5; red on exposed faces, grayish blue when freshly fractured, porous, with b clay-build cavities. No. 564 is a dense specular ore from pit No. 8.

The *Riverside* bank, in Sec. 2, T. 33, R. 5 W., has been recently opened and connected by rail with the Salem and Little Rock railroad at Salem. Several hundred tons of specular ore were taken from the area marked B, Fig. 170, where the ore was first attacked, but the bulk of the output was coming from A A when the bank was visited, and was a soft, unctuous, purple ore, surrounding denser cores of a greenish hue.

c



d

FIG. 168.—SKETCH OF THE RIVERSIDE BANK, DENT COUNTY, MISSOURI.

Two samples were here taken, which offer a direct comparison between the soft, unctuous hematite and the dense specular from which it is derived by decomposition. These samples were subjected to complete analysis, with the following results:

	565.	566.		565.	566.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sulphur	0.020	0.179	Carbon in carbonaceous matter	0.01	0.02
Phosphorus	0.029	0.063	Hygroscopic water	.....	0.40
Iron, metallic	63.90	64.05	Water of composition	0.15	3.15
Phosphorus ratio	0.045	0.098	Total	99.903	99.800
Silica	7.15	2.56	Per cent. of insoluble silicious matter	7.95	3.56
Iron, protoxide	1.19	0.46			
Iron, peroxide	89.93	90.77	Silica	7.15	2.56
Alumina	0.81	1.35	Alumina	0.80	1.01
Lime	0.34	0.13	Lime	0.01	0.02
Magnesia	0.09	0.06	Magnesia	0.05	0.04
Iron, disulphide	0.037	0.337			
Carbonic acid	0.13	0.12	Total	8.01	3.63
Phosphoric acid	0.066	0.143			

e

Sample 565 is the specular ore from B. Sample 566 is the soft hematite from A A. f

Simmons' Mountain, one of the largest deposits of specular ore in this region, is situated a quarter of a mile southwest of Salem, in the NW. ¼, Sec. 24, T. 34, R. 6 W. The deposit, occupying the center of a hill 90 feet high, has been worked in a large open cut, 300 to 400 feet wide at the top and irregularly excavated to a depth of something over 100 feet. The mountain had yielded, up to May 1, 1880, 164,763 tons. The bulk of the ore now occupies the bottom of the south side of this vast pit, where it is being mined by sinking vertically. This portion of the workings was flooded at the time when visited, and no samples could be obtained from the greatest depth upon the bed. Extensive stripping was in progress over the greater part of the pit, banks 80 feet high being thrown down in places. On this account the working faces were concealed and no opportunity was offered for sampling the varieties of ore, which are specular and both hard and soft hematite.

a A sample was taken which attempts to represent an average of the ore as now mined, though it was confined to 100 tons taken from the southwest side of the deepest working level and from the northeast side of the upper level, near the crown of the hill. It is a mixture of lump hematite and specular ore. This sample gives, upon analysis—

	560.
	Per cent.
Metallic iron	61.97
Phosphorus	0.039
Phosphorus ratio	0.063

b

The *Milsap and Orchard* bank is situated in the southern outskirts of the town of Salem. The open cut is 150 feet in width and 85 feet deep. The body of the hill is of sandstone, which as now exposed forms a broken wall on the east side of the pit through which the opening cut was made. The bottom of the pit was flooded to the depth of 12 feet, and therefore inaccessible. The slope of the hill east of the mine was scattered with surface lumps of specular ore. The product of the mine was a dense, blue specular ore, surrounded by soft, earthy hematite, both varieties being represented in a stockpile of some hundred tons. The following are analyses of these ores:

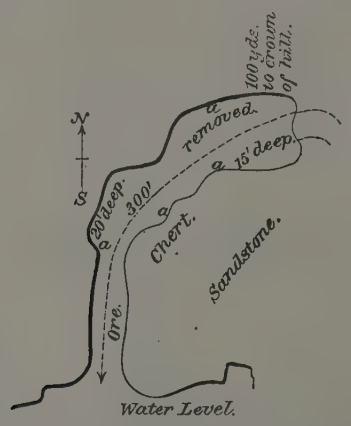
c

	561.	562.
	Per cent.	*Per cent.*
Metallic iron	57.96	60.39
Phosphorus	0.067	0.040
Phosphorus ratio	0.116	0.066

No. 561 is an average sample of a mixed pile of earthy hematite and specular ore, the hematite comprising two-thirds of the pile. No. 562 is the surface ore, from 20 tons after jigging.

The *Pomeroy* bank in the NW. and SW. ¼, Sec. 10, T. 34, R. 6 W., has proved one of the most extensive in this vicinity. Fig. 171 shows the present opening, which has reached a depth of about 20 feet, and shows shoulders of ore over the greater part of the bottom. Large masses of specular ore have been removed from the body of the d pit, though at present the ore is principally hematite. This hematite is for the most part an altered limonite, and shows the stalactitic forms of the latter, while beautiful specimens of limonite are found near the surface of the hill, and at times deeper in the cut, having the radiating structure due to the rose crystals of pyrite from which they are derived. Rich masses of unctuous hematite, having a botryoidal form, sometimes drawn out into contorted stalactites, are also found. Porous varieties of limonite of a gray tint are found in the body of the deposit, closely associated with the specular ore; the cavities in such cases are filled with a rich red clay.

e



f

FIG. 171.—SKETCH OF THE POMEROY BANK, DENT COUNTY, MISSOURI.

The ore represented by the sample is principally a hard hematite, showing some lumps of limonite, and giving, upon analysis—

	558.
	Per cent.
Metallic iron	59.99
Phosphorus	0.079
Phosphorus ratio	0.132

The *Thomas* bank in the NE. ¼, Sec. 20, T. 34, R. 6 W., shows some peculiarities in its manner of occurrence. Fig. 172 gives the dimensions of the pit upon the deposit. The shape of the ore-mass removed up to the present

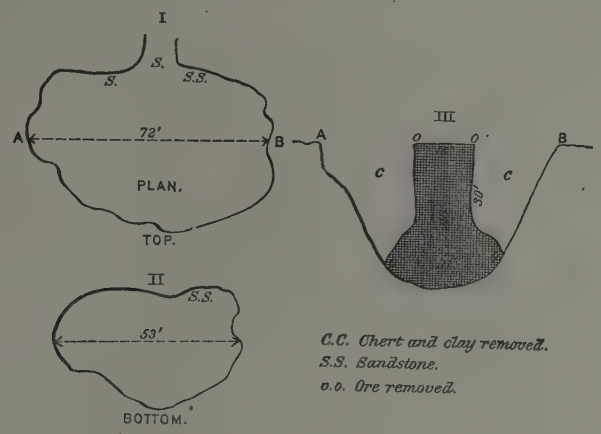


FIG. 172.—SKECH OF THE THOMAS BANK, DENT COUNTY, MISSOURI.

time is shown in III and resembles an inverted funnel occupying a cavity in a bed of mixed sandstone, associated with chert. The ore is principally a soft hematite, showing lumps of fine columnar stalactitic ore at times. Some of these stalactites are jointed and somewhat resemble crinoid stems. The sample taken from the whole bottom of this pit, composed of soft crumbling hematite alone, gives upon analysis—

	559.
	Per cent.
Metallic iron	57.78
Phosphorus	0.127
Phosphorus ratio	0.220

Sligo furnace, now in course of erection, is situated in the SW. ¼ Sec. 4, T. 35, R. 4 W. The *Sligo* bank has been recently opened 2 miles east of the furnace. The ore so far taken out is all hematite, both hard and soft varieties. Fig. 173 shows the opening cuts upon the hill. Test-pits expose at (*a*) 6 feet of ore, at (*b*) 3 feet, at (*c*)

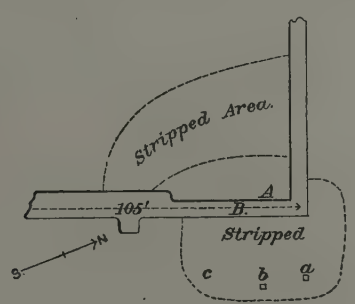


FIG. 173.—SKETCH OF THE SLIGO BANK, DENT COUNTY, MISSOURI.

none. At *B* at a depth of 3 feet is a bed of the finest most unctuous variety of paint-ore, 7 feet thick, overlain by a thin layer of bright yellow ocher, while a harder variety of hematite overlies this. Samples were taken from both varieties. The analyses are as follows:

	567.	568.
	Per cent.	*Per cent.*
Metallic iron	65.92	65.03
Phosphorus	0.040	0.026
Phosphorus ratio	0.061	0.040

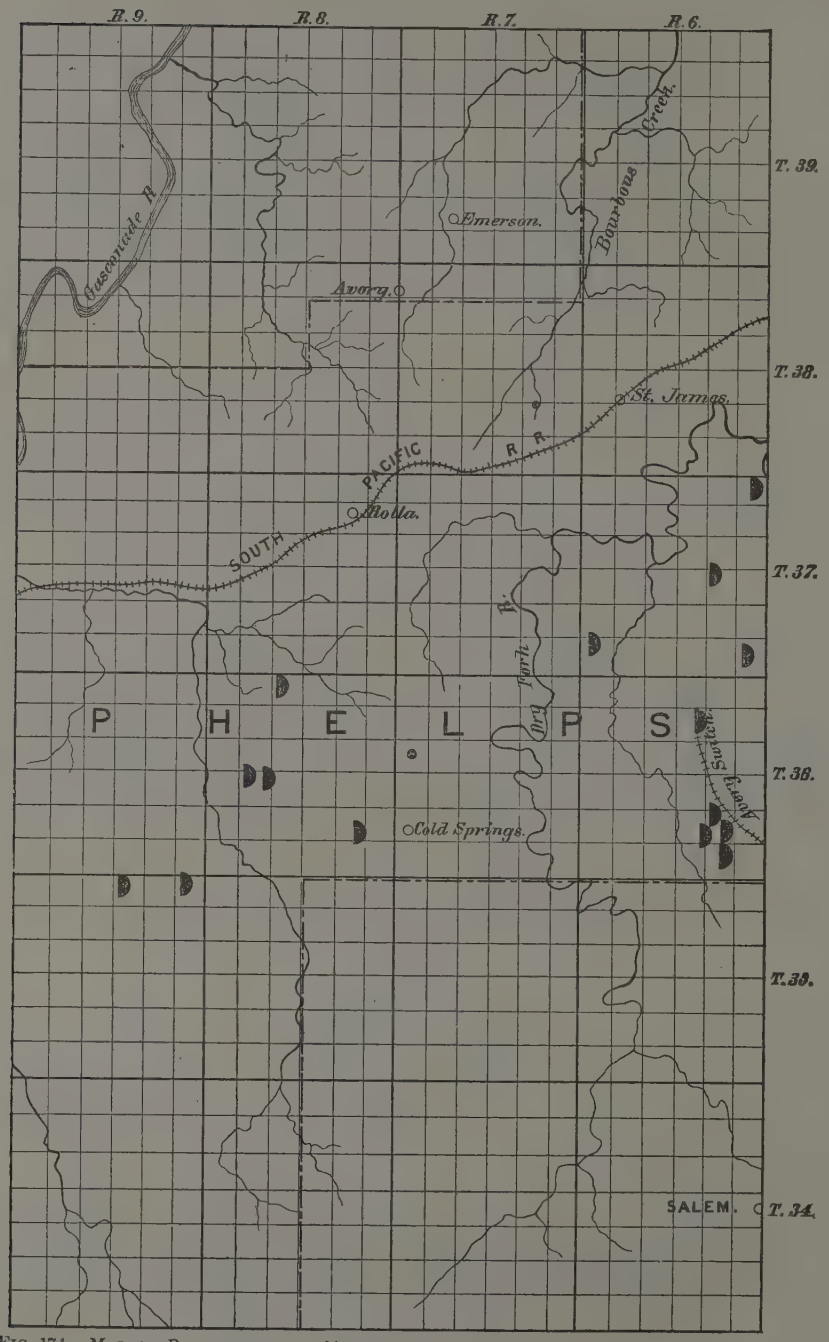


FIG. 174.—MAP OF PHELPS COUNTY, MISSOURI, SHOWING BANKS OF SPECULAR ORE SAMPLED.

No. 567 was taken at *A* from hard hematite partly mixed with soft ore. No. 568 is the finest variety of greasy paint-ore from *B*. a

Fitzwater bank, in the NE. ¼ Sec. 33, and the NW. ¼ Sec. 34, T. 35, R. 4 W., has been recently opened for Sligo furnace. A shaft was here sunk through 27 feet of solid specular ore. Twenty tons of ore from this shaft offered a fair sample. Some of the lumps show clusters of quartz crystals and yellow jasper, surrounded by clear blue, rather granular specular ore, and coated with red oxide. A sample from this pile shows, upon analysis—

	569.
	Per cent.
Metallic iron	62.95
Phosphorus	0.035
Phosphorus ratio	0.056

b

The Norris bank in the E. ½ Sec. 13, T. 34, R. 5 W., and the Thompson bank, in Sec. 26, T. 36, R. 4 W., are now opened for mining.

Watkins bank, in the NW. ¼ of the NE. ¼ Sec. 12, T. 35, R. 7 W., has been recently opened. The ore is a soft, unctuous hematite, showing many concretionery forms—nodules, hollow shells, and pipe-stems—with a radiating structure in the core, being common forms. Near the surface lumps of limonite are found, showing large rose crystals of unaltered pyrites, sometimes several inches in diameter, the radiating structure of which is presented when the mineral is thoroughly altered to limonite, and even when the limonite in turn has become hematite. The analysis of the soft hematite alone gives— c

	555.
	Per cent.
Metallic iron	59.30
Phosphorus	0.070
Sulphur	0.069
Phosphorus ratio	0.118

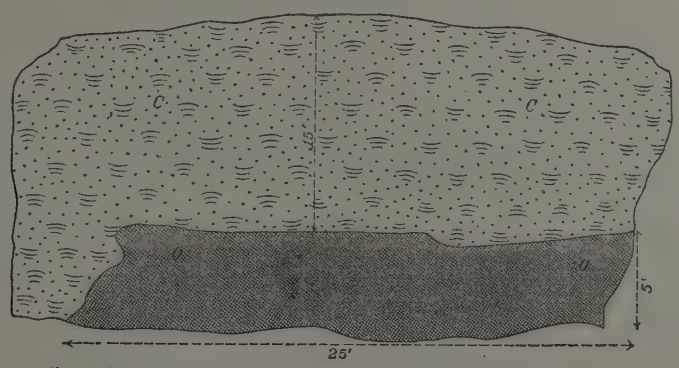
d

Dry Fork bank, in Sec. 6, T. 35, R. 6 W., is to be opened for mining, surface-ore being now hauled to Avery switch.

PHELPS COUNTY.

A large quantity of ore is at present mined in T. 36, R. 6 W., along a branch-track of the Salem and Little Rock railroad known as Avery switch.

The *Lamb* bank, in the NW. ¼ Sec. 35; the *Brady* bank, in the SW. ¼ Sec. 26; *Smith* No. 1 and No. 2; the *Clinton* bank, in the NW. ¼ Sec. 26, and the *Stimson* bank in the NE. ¼ Sec. 10, are the deposits at present worked, though preparations are being made for other openings. e



f

C.C. Clay.
O.O. Hematite.

FIG. 175.—SECTION AT BRADY BANK, PHELPS COUNTY, MISSOURI.

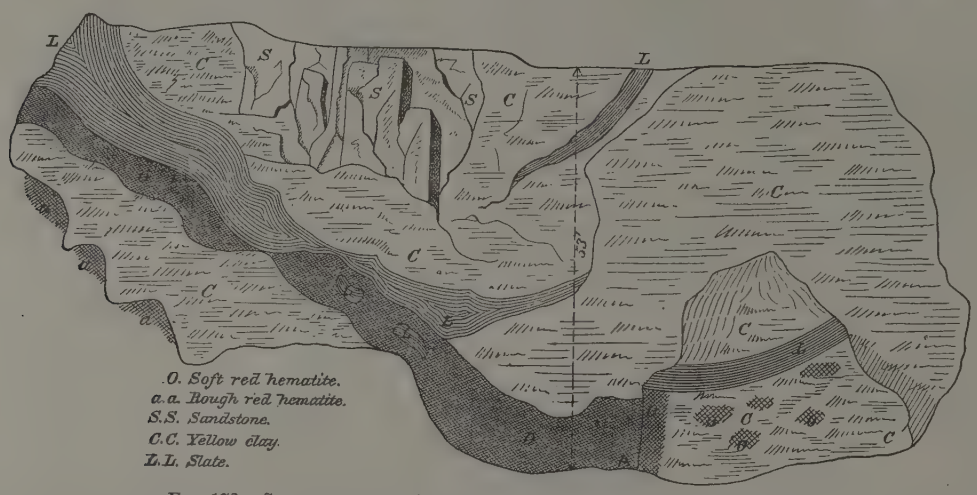
The Smith banks, Nos. 1 and 2, seem pretty nearly exhausted, and are no longer worked. The Lamb bank was yielding a fine quality of blue specular ore, and was opened on the south side of the track by a small cut 100 feet long and 10 feet deep.

a An illustration of the variable nature of some of these deposits, and the uncertainty as to their extent, was offered at the Brady bank.

The opening at the time was a small one, 30 feet square and 15 feet deep, which had yielded a soft hematite, occurring in clay, free from chert or sandstone. When the ore was thought to be exhausted, and four walls of yellow clay alone appeared in the pit, it was decided to put in a final blast on the west side. A charge was therefore driven and the bank was thrown down, when the section shown in Fig. 175 was exposed, which was yielding good ore when visited some weeks later.

The Clinton bank has proved to be one of the most productive in this township. The deposit lies well upon the crown of the hill and has been opened by a pit 200 feet long and 100 feet wide, which descends along an inclined b bed of sandstone, to which the ore-bed conforms. Fig. 176 shows a sketch of the east wall of the pit. At a depth of 50 feet the ore seems to dip under the sandstone, and a tunnel is now being pushed horizontally at A.

c


L
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Seven miles south of Saint James, in the NW. ¼ Sec. 1, T. 37, R. 6 W., the old *Maramec* furnace, a built in 1826 and now abandoned, ran for many years upon ore from a large lenticular deposit of specular ore occupying the body of a prominent hill near by. The excavation is a circular one, several hundred feet wide and 80 feet deep. In its center stands a high mound of clay rising almost to the original level of the hill, and pierced some distance from the bottom by tunnels, from which a soft, unctuous hematite was taken. In the bottom of the old pit, which still contains a considerable quantity of ore, a shaft was sunk 35 or 40 feet deeper, reaching a depth of 115 feet from the surface, but no further ore was struck. The shaft was filled and the working-faces all around the pit were fallen and covered. For a further description, see *Geological Survey of Missouri*, 1872, Part I, page 144. Not enough ore was left uncovered in the pit to offer a fair sample, but from a pile of 10 tons of hematite at the top of the furnace-stack a sample was taken, giving, upon analysis— b

	570.
	Per cent.
Metallic iron	63.28
Phosphorus	0.050
Phosphorus ratio	0.079

The ore was a dark red hematite which had lost all its natural moisture during four years of exposure in the furnace stock-house. c

The district immediately south of the towns of Rolla and Saint James is thickly scattered with small deposits of specular ore and hematite, the occurrence of which is similar to those above described.

The following list includes only those banks either at present worked or about to be opened for mining purposes:

Horse Hollow bank, NW. ¼ Sec. 1, T. 35, R. 9 W.; Ozark bank, NW. ¼ Sec. 3, T. 35, R. 9 W.; Mozelle, No. 1 bank, SE. ¼ Sec. 26, T. 36, R. 8 W.; Mozelle, No. 2 bank, NE. ¼ Sec. 20, T. 36, R. 8 W.; Southgate bank, NW. ¼ Sec. 20, T. 36, R. 8 W.; Railroad bank, NW. ¼ Sec. 4, T. 36, R. 8 W.; Grand Union bank, Sec. 31, T. 37, R. 6 W.; McDole bank, NW. ¼ Sec. 23, T. 37, R. 6 W.; Cole bank.

Fig. 174 shows the position of the *Horse Hollow* bank, which has been recently opened by a small cut, A, on d

e

Fig. 177.—Sketch of the vicinity of Horse Hollow bank, Phelps county, Missouri.

the south side of a prominent hill of sandstone, which rock is found outcropping largely on the crown of the hill and lying in large bowlders at C 1, immediately above the ore-deposit. The cut A is 30 feet long and 20 feet deep, and exposes a very soft, greasy, paint-ore. At B a pit 12 feet deep showed no ore.

From the *Ozark* bank only a few tons of ore had been taken, which were sampled at Ozark furnace. These ores show, upon analysis— f

	571.	572.
	Per cent.	*Per cent.*
Metallic iron	55.73	45.76
Phosphorus	0.032	0.042
Phosphorus ratio	0.057	0.092

No. 571 is a soft paint-ore from Horse Hollow. No. 572 is an earthy hematite, with much surface clay and some specular ore from Ozark.

The *Grand Union* and *Mozelle* banks were sampled at Rolla from stock-piles of some hundred tons. The ore so far mined is mostly a soft, earthy hematite, with some specular lumps. The specular ore from Grand Union often

a presents a bright-green appearance, due to the presence of carbonate of copper. The quantity of copper is at times large, and such lumps effervesce violently in acid. The following analyses offer comparisons:

	573.	574.	582.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	54.76	55.21	31.62
Phosphorus	0.121	0.074	0.027
Copper, metallic	2.46	.....	21.60
Phosphorus ratio	0.221	0.134	0.085

b No. 573, soft hematite associated with green specular lumps, but separated in the sample from Grand Union bank. No. 574, an earthy hematite from the Mozelle bank. No. 582, from green specular lumps alone at Grand Union. Sampled on cars at the Vulcan Steel Works.

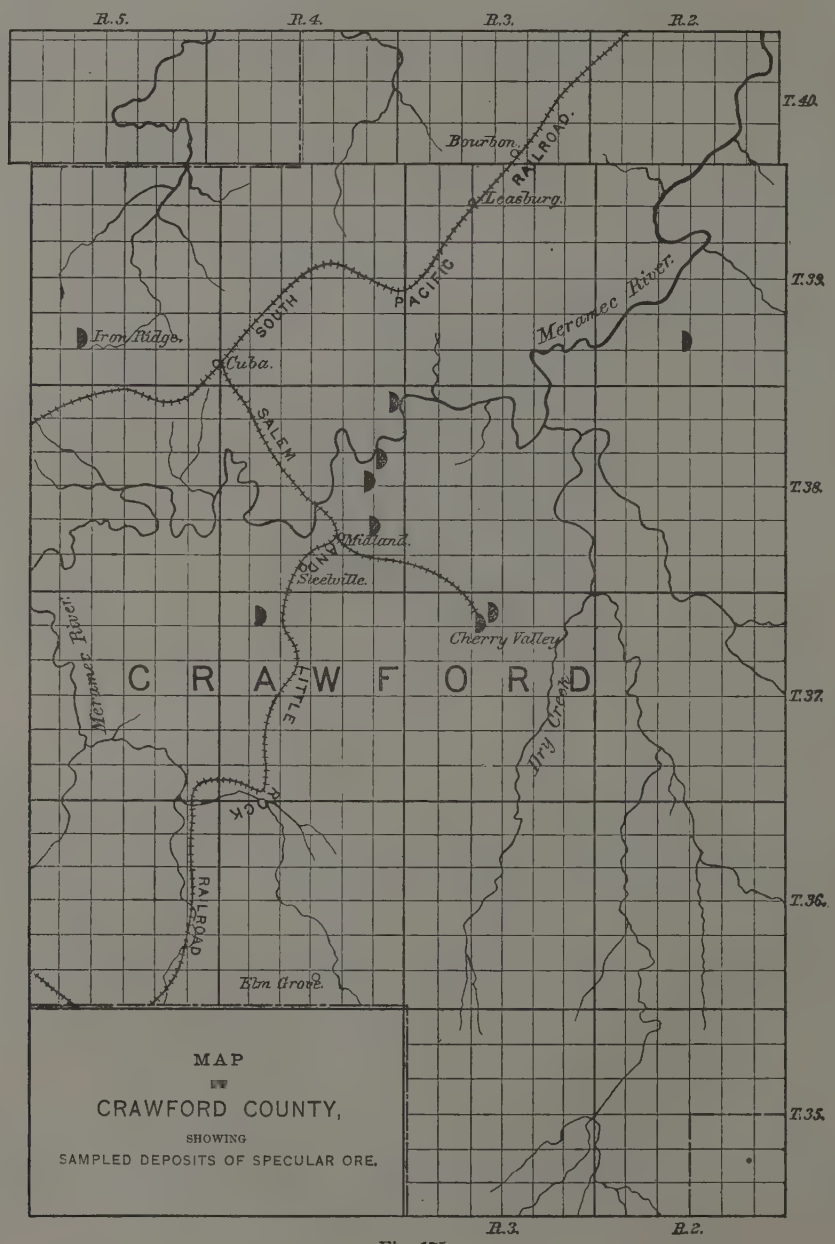


Fig. 175.

CRAWFORD COUNTY.

Iron Ridge mine, which has been extensively worked for ten years, still yields large quantities of ore. A **a** description of the deposit as it appeared ten years ago may be found in *Missouri Geological Survey*, pp. 142, 143, Part I.

Fig. 179 shows, I, a section through the hill before opening, which is partly ideal, and taken from notes kept by Mr. W. A. Dorey, president, and II, a plan of the pit and underground workings from actual measurements. In I, A, B, C, D shows the limits of the present circular pit. The greatest depth reached is at K, which is about 20 feet below the bottom of the main pit, and is connected by a short incline, T, with the upper levels. Around the bottom of the pit the ore is worked in a number of short tunnels, *a*, *a*, *a*, **b** while at E a bunch of specular ore is exposed. The bulk of the ore composing the great inverted funnel shown in I was hematite, though broken lumps of partly altered specular ore were met with throughout. The mine, up to May, 1880, had yielded 190,000 tons.

The sample taken represents the hematite from the head of the lowest entry at K, the greatest depth reached upon the vein, and gives, upon analysis— **c**

	575.
	Per cent.
Metallic iron	61.36
Phosphorus	0.124
Phosphorus ratio	0.202

In the SW. ¼ Sec. 5, T. 37, R. 4 W., the *Marsh* bank has recently been opened, and a shaft sunk through a bed of hematite 30 feet thick. A sample was taken from this opening **d** from a pile of some 50 tons, which gives, upon analysis—

	576.
	Per cent.
Metallic iron	58.07
Phosphorus	0.058
Phosphorus ratio	0.100

The ore was somewhat contaminated by **e** surface clay, consequent upon opening and stripping.

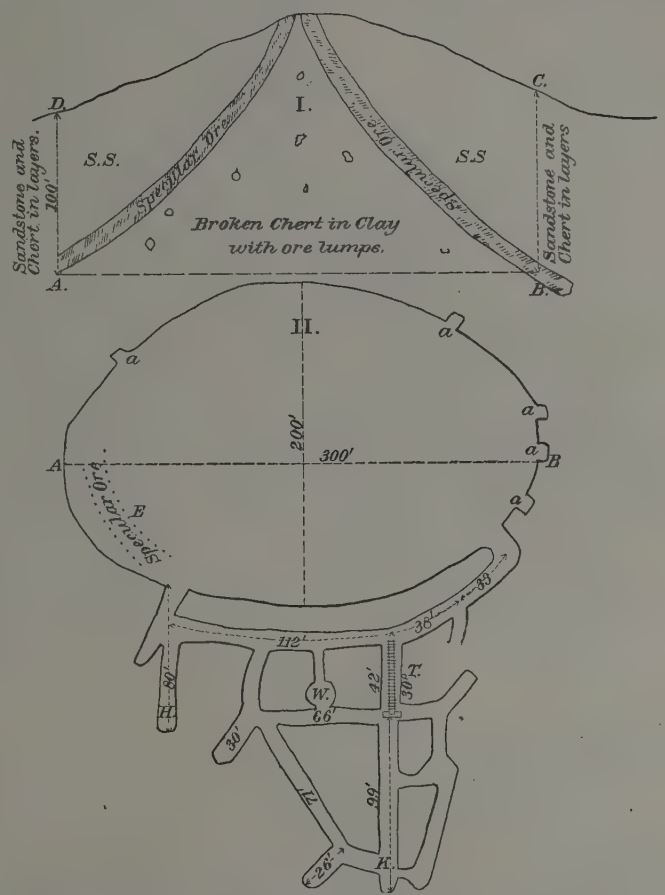


Fig. 179.—Sketch of the Iron Ridge mine, Crawford county, Missouri.

The *Zane* bank, in the NW. ¼ Sec. 13, T. 38, R. 4 W., was worked for Midland furnace, but is now exhausted. This deposit presents some interesting peculiarities.

Fig. 180 shows a plan of the pit and a section across it. The ore-bed occupied a narrow crevice in the chert, 110 feet long, and inclining 30° to the south.

The section shows (*e*) 14 feet of chert and clay, (*a*) 3 to 4 feet of dense chert, (*b*) 3 feet of soft hematite. From (*c*) was taken a single huge bowlder of specular ore, containing 120 tons. When first visited, on May 8, the pit had reached the dimensions shown in the cut, and preparations were being made for undercutting and following **f** the ore with the dip (*b*, F). Ten days later the crevice came suddenly to an end, terminating the ore-bed at F. The Zane bank yielded about 700 tons of ore in all.

A sample of soft but compact hematite from K gives, upon analysis—

	548.
	Per cent.
Metallic iron	59.20
Phosphorus	0.080
Phosphorus ratio	0.135

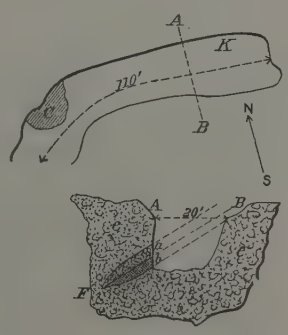


Fig. 180.—Sketch of the Zane bank, Crawford county, Missouri.

a At the *Railroad* bank, in SE. ¼ Sec. 14, T. 38, R. 4 W., two openings have been made. A gray sandstone, resembling a quartzite, is cut by the east pit, while the west opening exposes masses of highly-colored chert. The ore varies from blue specular to a dense hard hematite, occurring irregularly through the bed of chert and clay.

The *Clark* bank, in the NE. ¼ Sec. 26, T. 38, R. 4 W., is but partly opened. Lumps of specular ore are found scattered over the surface of a low hill and to a depth of 4 feet in the clay. From one part of the opening some few tons of soft hematite have been taken, though the ore is much mixed with the surface clay.

Analyses of the ores from these two banks show results as follows:

b

	547.	549.
	Per cent.	*Per cent.*
Metallic iron	59.41	55.37
Phosphorus	0.085	0.075
Phosphorus ratio	0.143	0.135

No. 547 is from all parts of the Railroad bank, representing both hard hematite and specular ore. No. 549 is from the Clark bank, from soft hematite alone.

The *Cherry Valley* mine is one of the most productive in the region under discussion. It is situated in the SW. ¼ and the SE. ¼ Sec. 4, T. 37, R. 3 W.

c Fig. 181 is a plan of the main pit No. 1. This is an annular deposit, conforming to its sandstone walls. The ore is a typical blue specular, in which the drusy cavities are unusually beautiful, being lined as above described with splendent, many-colored crystals. Associated with this, the usual soft hematite occurs in large quantities.

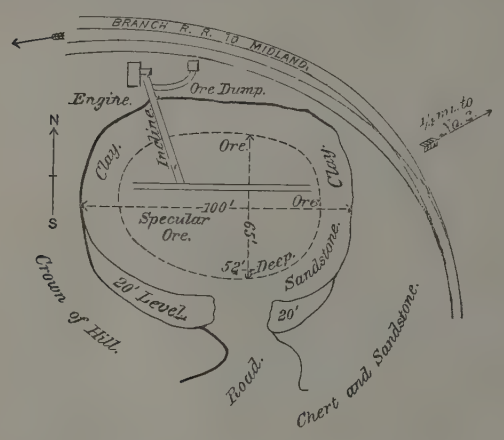


FIG. 181.—SKETCH OF THE CHERRY VALLEY MINE, No. 1, CRAWFORD COUNTY, MISSOURI.

Pit No. 2 is in the SE. ¼ of Sec. 4, and a quarter of a mile northeast of No. 1. This is an irregular opening showing no defined limits. The mass of the ore at the time when visited was an earthy hematite, though at the north end of the pit near the top of the cut a ledge of specular ore was exposed. Much of the d ore from this pit is a purple, crumbling variety, pierced in all directions by cores of half-altered specular ore. The two pits have yielded since 1878 84,651 tons.

The analyses of samples taken, are as follows:

	535.	550.	551.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	57.18	65.87	58.588
Phosphorus	0.082	0.022	0.085
Phosphorus ratio	0.143	0.033	0.145

e

No. 535: From stock at Missouri Furnace Company, Saint Louis. No. 550: Specular ore alone, from the bottom of No. 1. No. 551: Average of the soft hematite and purple ore from all parts of pit No. 2.

Sample 550, upon complete analysis, yields results as follows:

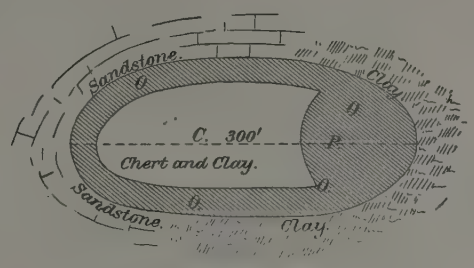
f

	550.		550.
	Per cent.		*Per cent.*
Sulphur	0.159	Carbon in carbonaceous matter	0.02
Phosphorus	0.022	Hygroscopic water	0.14
Iron, metallic	65.87	Water of composition	0.98
		Total	100.056
Silica	3.06		
Iron, protoxide	0.82	Per cent. of insoluble silicious matter	3.39
Iron, peroxide	93.01		
Alumina	1.27	Silica	3.06
Lime	0.28	Alumina	0.16
Magnesia	0.07	Lime	0.13
Iron, disulphide	0.255	Magnesia	0.05
Carbonic acid	0.04		
Sulphuric acid	0.06	Total	3.40
Phosphoric acid	0.051		

The *Scotia* bank, No. 1, situated in the SE. ¼ Sec. 28, T. 39, R. 2 W., has been widely known on account of the beauty of its specular ore. Here more than at any other locality were found the drusy cavities glittering with

quartz crystals and glowing with a thousand varied colors, rendering the ore recognizable wherever seen. The a history of the Scotia bank, which is now exhausted, is derived from a description given by Mr. Thomas J. Scott. For a geological description of its surroundings, see *Geological Survey of Missouri*, Part I, p. 128. This is a very perfect example of a lenticular deposit.

The sketch given in Fig. 182, showing a horizontal plan of the pit, though somewhat ideal in the regularity of its lines, is not exaggerated in other respects.



b

FIG. 182.—PLAN (PARTLY IDEAL) OF THE SCOTIA MINE, CRAWFORD COUNTY, MISSOURI.

The ore following the sandstone wall of the ellipse extended to the depth of 60 to 80 feet, but at the east end c of the pit at P, sunk downward in a great cylinder 100 feet thick, to a depth of 130 feet.

At this depth a sump was dug, which, after piercing a few remaining feet of ore, passed through 13 feet of pyrite but little decomposed and presenting a high metallic luster.

This portion of the pit was filled with water to the level (C) 60 feet below the original opening on the hillside. But little ore remained in the pit, and the sample was collected from pickings here and there along the old tramway and from scattered lumps in the stock-house of the furnace. The greater part of the ore which supplied Scotia furnace ten years and yielded 73,000 tons of pig metal was a porous hematite coming from the bed either in rough lumps or in a fine, soft, earthy condition, greasy to the touch. Scattered more or less thickly through this hematite the specular ore above described was found. The analysis of the sample collected here gives—

d

	577.
	Per cent.
Metallic iron	63.10
Phosphorus	0.063
Phosphorus ratio	0.091

The *McGarvey* bank, a small opening 8 miles southwest of Leasburg, completes the list in Crawford county from which samples were taken. A stock-pile containing 65 tons was sampled at Leasburg, representing only soft paint-ore, and yielding, upon analysis—

e

	578.
	Per cent.
Metallic iron	61.42
Phosphorus	0.056
Phosphorus ratio	0.115

FRANKLIN COUNTY.

But little ore is mined in Franklin county. The *Staunton* bank, 2 miles southeast of Staunton, was opened in November, 1879. Fig. 183 shows the shape and dimensions of the pit when visited in May, 1880.

The ore was exposed in shoulders at O, O, O, wherever the clay had been removed, and is 16 feet deep at A, f where a pit has been sunk. It is a compact earthy hematite, somewhat specked with included pieces of chert, which is for the most part decomposed to a soft chalk. At B a dark purple ore occurs in boulders intimately associated with chert, which is also found in angular fragments in the clay. A sample taken from 300 tons in stock at Staunton is here compared with a second sample from the stock-pile of the Missouri Furnace Company:

	581.	534.
	Per cent.	*Per cent.*
Metallic iron	58.81	57.85
Phosphorus iron	0.058	0.072
Phosphorus ratio	0.099	0.124

a No. 581, from Staunton. No. 534, from pile at Missouri Furnace Company, Saint Louis.

The *Saint Clair* or *Busket* bank, in the SE. ¼ Sec. 28, T. 42, R. 1 W., has been newly opened. The surface of the hill shows a scanty scattering of limonite, and deeper upon the bed the ore is a soft hematite of a brown

b

c

FIG. 183.—SKETCH OF THE STAUNTON BANK, FRANKLIN COUNTY, MISSOURI.

d color, due to clay, and interstratified with layers of sandy chert and streaks of brownish shale, much contorted. Occasional lumps of specular ore are met with. The careful separation of the ore from the clay and chert will be necessary to render it of value. The following results were obtained from two samples taken:

	579.	580.
	Per cent.	*Per cent.*
Metallic iron	62.40	58.86
Phosphorus	0.059	0.058
Phosphorus ratio	0.095	0.099

e No. 579, from 100 tons in stock at Saint Clair station. No. 580, from a mixed pile of recently-mined ore at the mine.

Besides the deposits above described there are in this region many located banks, and probably many which have not yet been opened for mining purposes.

As may be seen from the above examples, the size of a deposit can in no case be estimated from mere surface indications, as the occurrence of the ore is both variable and uncertain, and what seems to be an existing rule in one instance is proved untrustworthy in others. Already numerous deposits which seemed to promise a large amount of ore have been exhausted, while others, promising but little from surface indications, have opened into large workings. A sample of ore was taken from the mixed stock-pile of the Missouri Furnace Company, Saint Louis.

f It represents ore from nine banks, namely: *Cherry Valley*, *McGarvey*, *Saint Clair*, *Handcock* (exhausted), *Horse Hollow*, *Stimson*, *Staunton*, *Pomeroy*, *Lamb*, and was composed of all the varieties of specular ore and hard and soft hematite. It yields, upon analysis, results as follows:

	536.
	Per cent.
Metallic iron	56.43
Phosphorus	0.065
Phosphorus ratio	0.115

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN MICHIGAN AND NORTHERN WISCONSIN.

By Bayard T. Putnam.

Iron ores in the upper peninsula of Michigan have thus far been found only in the Huronian series of rocks. This series consists of quartzites, schists, banded jaspers, greenstones, limestones, and iron ore, and contains in

Fig. 184.—Map of parts of Michigan and Wisconsin, showing position of belts of iron ore. The geology is from a map compiled by R. D. Irving, published in *Trans. Am. Inst. Min. Eng., Vol. VIII.*

Note.—The boundaries of the field of Laurentian rocks in the eastern part of the Menominee region have not been definitely mapped.

REFERENCE.
Specular Ores
Magnetic Ores
Magnetic and Slate Ores
Soft Hematites of Prof. J. Brooks)
" " " " XII. "
Flag Ores.
POTSDAM SANDSTONE
HURONIAN
LAURENTIAN
Dead River
Escanaba River
Menominee River
Marquette
Negaunee
Ishpeming
Michigamme
Champion
Humboldt
Republic
Columbia
Magnetic
Chesbrook
Mt. Pleasant
Mt. Bruno
Mt. Mitchell
Mt. Palmer
Mt. Wheat
Mt. Cleveland
Mt. Orchard
Mt. Lake
Mt. Lowthian
Mt. Saginaw
Mt. Goodrich
Mt. Barnum
Mt. Lake Superior
Mt. Section 13
Mt. Excelsior
Mt. New Orleans
Mt. Cambria
Mt. Bessemer
Mt. Cyclopean
Mt. Cyclopean
Mt. Cyclopean

all, according to Brooks, twenty distinct members. (*a*) On Brooks' scheme these members are numbered from I to **a** XX. Iron ore has been proved to exist in workable quantities in beds VI, X, XII, and XIII, and in an horizon below V.

The accompanying map (Fig. 184) shows the distribution of the Huronian rocks in the portion of the upper peninsula containing the iron deposits now being worked. (*b*) The mines lie in two distinct groups or belts, approximately parallel, the one about 40 miles south of the other. The northern belt is called the Marquette iron region, and the southern belt the Menominee iron region.

THE MARQUETTE IRON REGION.

This region embraces the Huronian rocks, extending from Marquette westward, and contains all the iron mines **b** on the upper peninsula that shipped ore previous to 1877. At Marquette the Huronian field is about 6 miles wide. From there it widens to 13 miles at Negaunee, and thence narrows to Michigamme lake, where it is not more than 3 miles in width. Geologically, the strata form a broad synclinal trough, corrugated in the direction of its axis by several minor folds, resting on Laurentian rocks. The general trend of the formation is east and west. South of Michigamme lake a narrow tongue of Huronian is separted from the main field on the west by a Laurentian peninsula. On the southern extremity of this tongue is situated the Republic mine, the largest single deposit of ore in Michigan, and one of the largest in the world. About 20 miles south of Marquette, in township 45, range 25, there is a small isolated patch of Huronian rocks, surrounded on three sides by Laurentian, and on the fourth by Silurian strata, in which is situated the Cheshire mine; and northwest of Michigamme lake, in township 49, **c** range 33, is the so called L'Anse range. With the foregoing exceptions the mines of the Marquette region are in one comparatively compact belt.

From Marquette to near Negaunee the upper members of the Huronian appear to be wanting. The most easterly deposits of iron ore known, excepting the Cheshire, are the so-called "soft hematites" about Negaunee, which are believed to belong to bed X. The specular or hard hematite ore first makes its appearance in traveling westward from Marquette, at the Jackson mine, immediately west of Negaunee. Here the basin formed by bed XIII, the horizon at which this ore occurs, is very narrow; but it widens toward the west, and at Michigamme lake its northern and southern rims are nearly 3 miles apart. All the ores of bed XIII contain some protoxide of iron, but in following the region westward the first deposit of magnetic ore is seen at the Humboldt mine, 13 miles west of the Jackson. At this locality specular hematite ("slate ore") is also present in considerable quantities; **d** but farther west, at the Michigamme and Spurr Mountain mines, the ore mass is almost entirely magnetite. The ferruginous schists likewise become more magnetic as they are followed west.

The "soft hematite" deposits in the Saginaw range, southwest of Ishpeming, belong to bed XII, and the "flag-ores" of the Cascade range, in the southern part of township 47, range 23; and of the magnetic range, near the center of township 47, range 30, are believed to be older than the quartzite of bed V. In the Marquette region no workable deposits of ore have been found in bed VI, the horizon of the ores of the Menominee region in Michigan, nor in bed XV, supposed by Brooks to be the horizon of the Commonwealth and Florence ores in Wisconsin.

The following description of the ores is mainly an abstract from Major Brooks' chapter on Lithology, in Vol. I of the *Geological Survey of Michigan:*

Only such ores as are now employed in the manufacture of iron will be mentioned. They are, in order of present supply, (*a*) the **e** specular hematite, or *red specular ore,* as this class is designated in the iron trade; (*b*) the *magnetic;* (*c*) the mixed or *second-class* ore, which may be either specular or magnetic; (*d*) the *soft hematite;* and (*e*) the *flag-ores.* Another variety, the magnetic specular, might be added, which, as the name implies, is a mixture of the black and red oxides; it gives a purple streak. The local terms, "hard", embracing both the magnetic and the specular ores, and "soft", for the soft hematites, are convenient.

(*a*) *Red specular ores.*—Miners divide these into *slate* and *granular.* The former resembles closely in its structure the soft greenish chloritic schists, commonly associated with it. The slabs, into which the ore easily splits, are not uniform in thickness like roofing-slate, but taper always in one and often in three ways, producing elongated pieces often resembling in form a short, stout, two-edged sword-blade, with surfaces as bright as polished steel, but striated and uneven. Thin edges of such slates can be pulverized into a bright-red powder by the finger-nail, and occasionally the whole mass is very friable. The magnet will generally lift 1 or 2 per cent. of the powdered ore, and occasionally one-fourth of the whole. In the latter case the streak is purple, and the ore is more friable than the pure red specular slates, due in some way to the larger admixture of magnetite.

The *granular* or massive specular ore shows no tendency to split in slabs, and is made up usually of minute crystalline grains, which **f** are sometimes, however, so large that their octahedral form can be easily recognized without the aid of a lens. The granular ore is generally firm in texture, and is never friable like the granular magnetic. Some highly-compacted varieties, which contain a little silica, are very hard, constituting the hardest rock to drill which the miner encounters. This variety is called the "fine-grained steely ore". Some specimens of it possess almost the highest specific gravity observed, 5.23, while the rich softer ores of the same class averaged about 4.85.

(*b*) *Magnetic ore.*—The description given above of the granular specular ore applies with equal force to this class, except that the latter is more granular and is often friable; it has the magnetic property, and gives a black or purple powder. Sometimes the rich magnetites crumble easily into grains, like some of the lake Champlain ores, to which the term "shot-ore" is applied; again, the ore is very hard. The compact tabular form, so frequent in the magnetic ores of New Jersey and southern New York, is not common in the best ores of the Marquette region, nor are the latter ores as highly magnetic as the former, or, at least, good lodestones are not so

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a *Geology of Wisconsin,* Vol. III, Table of Sequence of the Huronian Strata, facing p. 450. By T. B. Brooks.

b 1880. The Gogebic region in Northwestern Michigan and Northern Wisconsin (T. 47, R. 45, 46, and 47 W., Michigan; and T. 45 and 46, R. 2 E., and T. 46, R. 1 E. and 1 W., Wisconsin), in which there are now (1886) a number of important shipping mines, was a trackless wilderness in 1880, although the existence of iron ore in that vicinity was known.

a common. Typical *slate ores* occur with the magnetites, but they are of the character already described, that is, mixtures of the two oxides, the magnet not removing over one-fourth of the powder, while it takes all in the case of the granular variety.

(*c*) The *mixed* or second-class ores differ from those of the first class chiefly in containing a larger per cent. of silica. They are, in fact, highly ferruginous "jaspery" schists. These schists, which are invariably associated with the rich ores, consist of alternating bands or laminæ of the so-called jasper (a ferruginous quartz, varying in color from a bright red to a dull-reddish brown), and usually pure specular or magnetic ore of high luster. Occasionally the silicious layers are white. The laminæ vary in thickness up to an inch. They are usually parallel, but are sometimes highly contorted. In some cases the jaspery layers have been broken up into angular fragments, which have been forced into the more yielding ore-layers; in this case the mass often has the appearance of a true breccia. The total amount of oxide of iron contained in these ferruginous schists is very great, but it is at present, as a rule, unavailable for the manufacture of iron. Where the silicious laminæ are so thin that the whole mass contains 45 to 50 per cent. of metallic iron, it can be shipped as a second-class ore.

b (*d*) The *soft hematites* of the Marquette region differ entirely from the ores above described, and are closely related to the brown hematites of eastern Pennsylvania and Connecticut. Chemically, they are mixtures of the hydrous and anhydrous oxides; they contain usually oxide of manganese. In color they are various shades of brown, red, and yellow. In texture they are earthy, and are so slightly compacted as to be easily mined with pick and shovel. These ores are invariably associated with or occur in a limonitic silicious schist, from which they seem to have been derived by decomposition and disintegration. They occur in two distinct formations, X and XII, and probably in others, in irregular bunches or pockets, surrounded by schist, and passing by gradations, often abrupt, into it. Scattered through the ore, and conforming in their positions with the original bedding of the rock, are fragments of schist. When the ore shows stratification, which it often does not, it also conforms with the bedding of the schist.

(*e*) *Flag-ores* correspond more nearly to the *mixed ores* (*c*) than to any of the other varieties mentioned. Like the mixed ores, they are banded, but the marking is seldom bright and is often obscure, and is produced by the interlamination of reddish or whitish quartz with a dull *silicious*, instead of a pure, ore. There are exceptions to this rule, but they are not numerous. As their name implies, the c flag-ores have a coarse slaty or flaggy structure. Stratigraphically, they are older than the rich ores of bed XIII, occupying beds X, VIII, VI, and below V. The per cent. of metallic iron in the ores and associated schists varies from 5 to nearly 60. The ores are apparently but local variations of the schists.

Average samples of the shipping product of the principal mines of the upper peninsula were collected by Mr. Bailey Willis from the large stock-piles of ore at Cleveland, Ohio, in November and December, 1879. In addition to these, samples were taken by the writer in several of the typical mines of the Marquette region and in all the mines of the Menominee region, with the object of determining whether the ore from different parts of the same deposit varied in composition, especially as to its contents in phosphorus.

The samples taken by Mr. Willis were from piles varying from 1,000 to 20,000 tons. They were made up of chips of about an inch maximum diameter, taken at regular intervals of 1 foot along a number of straight lines drawn across the ore-piles. In the larger piles these lines were fixed by cords stretched across them. Lump ore, d fine ore, and foreign material were taken impartially. The total weight of the samples varied from 18 to 40 pounds, according to the size of the piles.

My samples consist generally of a series of chippings taken across the stope, from the hanging to the foot wall of the ore-mass, or across the band of ore selected for detail sampling. Where there was a seam or "horse" of rock in the ore which clearly could be thrown out in mining, no chippings of it were taken. But with this exception the sample represents as nearly as possible the material from a groove or channel cut across the ore-mass. In a few cases I have taken samples from the small stock-piles at the mines, in order to supplement those taken in the stopes.

In the following pages the analyses of the above-mentioned samples are arranged under the names of the mines to which they belong, and the mines are grouped according to the kind of ore produced, and are placed in each group, so far as possible, in order from east to west.

e The total output of the mines to the end of the year 1880 is taken from the *Annual Report of the Commissioner of Mineral Statistics of the State of Michigan for* 1880. The gross tons (2,240 pounds) there employed have, however, been reduced to net tons (2,000 pounds), as the latter unit is used exclusively in this volume.

Mines producing ore of Class I (hard specular).

(1) *Jackson.*—On Sec. 1, T. 47, R. 27 (at Negaunee). Operated by the Jackson Iron Company. It is the oldest mine in the Upper Peninsula; the original entry of the land was made in 1845, and about 28,000 tons were mined previous to 1854. Total product, 2,315,261 (*a*) tons. Product in census year, 134,584 (*a*) tons.

Samples of the ore collected at Cleveland by Mr. Willis contained—

f

	140.	150.		140.	150.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	64.84	62.09	Titanic acid	Absent.	Absent.
Phosphorus	0.044	0.064	Insoluble silicious matter	6.00	8.46
Sulphur	0.027	0.027	Phosphoric acid	0.100	0.147
Silica	4.02	5.69	Phosphorus in 100 parts iron	0.068	0.103
Alumina	1.76	2.78	Specific gravity	5.029	.....
Manganese	Absent.	Trace.	Per cent. iron, divided by specific gravity	12.89	.....

a These figures include the product of the Pioneer and South Jackson mines. The former is on the same body of ore as the Jackson, but is operated by the Iron Cliff Company. The latter produces soft hematite. *a* See samples Nos. 137 and 138, page 434.

Sample No. 140 is an average of a pile of 20,000 tons of "Specular No. 1". Texture of ore, compact, granular, a laminated. Sample No. 150 is a special sample of the fine ore in the same pile. It was sifted through a sieve containing 3 meshes to the linear inch.

(2) *Cleveland.*—On Secs. 10 and 11, T. 47, R. 27; operated by the Cleveland Iron Mining Company. Total product, 2,384,630 tons; product in census year, 125,440 tons. Samples of the ore collected at Cleveland by Mr. Willis contained—

	113.	131.		113.	131.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	64.47	56.80	Titanic acid	Absent.	Absent.
Phosphorus	0.109	0.170	Insoluble silicious matter	5.03	14.51
Sulphur	0.049	.....	Phosphoric acid	0.250	0.390
Silica	3.76	10.93	Phosphorus in 100 parts iron	0.169	0.299
Alumina	2.90	4.03	Specific gravity	4.965	4.795
Manganese	Trace.	Present.	Per cent. iron divided by specific gravity	12.98	11.84

b

Sample 113 is from 15,000 tons of "Specular No. 1"; texture of ore, compact. Sample 131 is from 1,100 tons "Specular No. 2", or green specular; texture of ore, compact.

(3) *New York.*—On SE. ¼ of SE. ¼ of Sec. 3, T. 47, R. 27, adjoining the Cleveland on north and west; operated c by the "New York Iron Mines". First shipment of ore in 1864; total product, 1,035,738 tons; product in census year, 44,971 tons.

The samples of ore collected at the mine yielded, on complete analysis—

	88.	89.		88.	89.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sulphur	0.060	0.030	Potassa	0.11	0.33
Phosphorus	0.062	0.195	Carbonic acid	0.09	0.12
Iron, metallic	67.34	63.81	Phosphoric acid	0.142	0.448
Phosphorus in 100 parts iron	0.092	0.306	Hygroscopic water	.....	0.10
Specific gravity	4.949	5.033	Water of composition	0.40	1.17
Per cent. iron divided by specific gravity	14.00	12.7	Total	99.974	100.034
Silica	1.89	3.04	Insoluble silicious matter	2.88	4.99
Iron, protoxide	0.81	3.08			
Iron, peroxide	95.22	87.69	Silica	1.89	3.04
Alumina	0.81	3.04	Alumina	0.86	1.55
Manganese	.....	Trace.	Lime	0.01	0.04
Lime	0.29	0.67	Potassa	0.11	0.33
Magnesia	.....	0.39			
Iron, disulphide	0.112	0.056	Total	2.87	4.96

d

c

Sample No. 88 is from a pillar in the southeastern part of the main pit (pit No. 1). The chippings were taken from floor of mine (which is ore) to the roof (rock). Texture of ore, compact; ore is very hard. Sample No. 89 is from ore from pit No. 4, a new opening in the Beardsley pit. Texture of ore, compact, slaty; contains small octahedral crystals of magnetite (or martite). Ore in mass deflects compass needle. [It is shipped as a No. 2 ore; see sample No. 115.] The location of samples Nos. 88 and 89 is indicated on Fig. 186.

The samples of ore collected at Cleveland by Mr. Willis contained—

	114.	115.		114.	115.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	64.40	64.34	Titanic acid	Absent.	Absent.
Phosphorus	0.110	0.164	Insoluble silicious matter	5.93	7.07
Sulphur	0.026	0.086	Phosphoric acid	0.252	0.376
Silica	5.10	5.82	Phosphorus in 100 parts iron	0.171	0.267
Alumina	2.20	2.98	Specific gravity	4.292	4.906
Manganese	Absent.	Present.	Per cent. iron divided by specific gravity	15.00	12.50

f

Sample No. 114 is from 9,000 tons of "Specular No. 1"; texture of ore, compact. Sample No. 115 is from 1,000 tons of "Specular No. 2, or "green specular"; texture of ore, compact, crystalline.

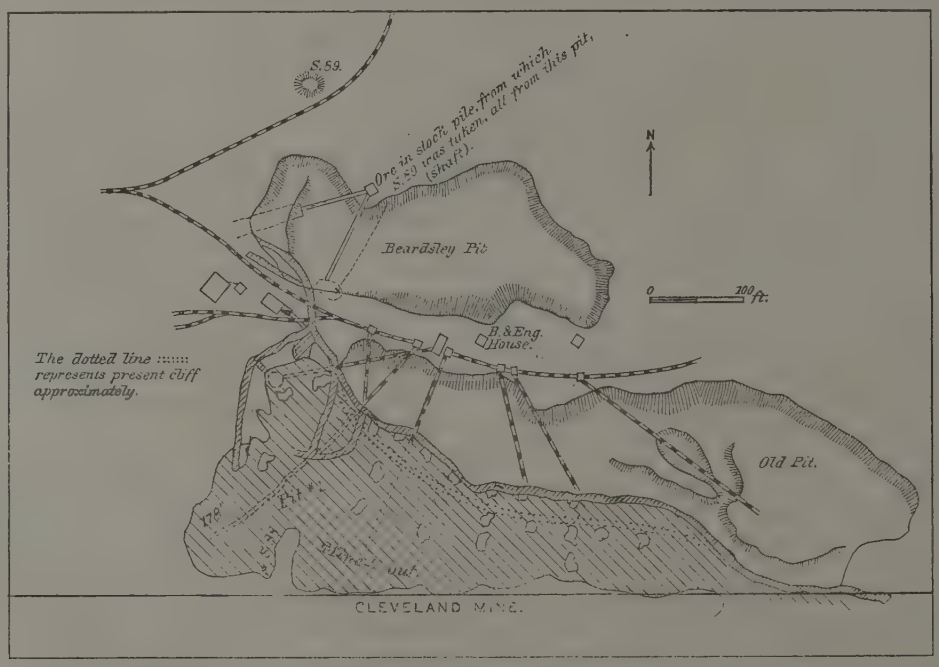
a (4) *Lake Superior.*—On Secs. 9 and 10, T. 47, R. 27 (at Ishpeming). Operated by the Lake Superior Iron Company. First shipment in 1858; total product, 2,664,115(*a*) tons; product in census year, 215,930(*a*) tons. Samples of the ore collected at Cleveland by Mr. Willis contained—

	141.	149.	139.	142.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	64.38	63.38	64.77	55.92
Phosphorus	0.057	0.057	0.016	0.057
Sulphur	0.074	0.057	0.055	0.074
Silica	4.27	4.66	3.65	14.51
Alumina	0.91	3.13	2.28	4.02
Manganese	Absent.	Absent.	Absent.	Absent.
Titanic acid	Absent.	Absent.	Absent.	Absent.
Insoluble silicious matter	6.43	7.58	6.35	17.65
Phosphoric acid	0.131	0.130	0.036	0.131
Phosphorus in 100 parts iron	0.089	0.090	0.025	0.102
Specific gravity	4.962	.....	4.990	4.318
Per cent. iron divided by specific gravity	12.97	.....	13.38	12.94

b

Sample 141 is from 20,000 tons of "Specular No. 1". Texture of ore, compact, laminated, micaceous. Sample 149 is a special sample of the fine ore from same pile (see under sample 150, Jackson mine). Sample 139 is from c 4,000 tons of specular ore from "Summit" opening, 300 feet west of main pit; texture of ore, compact. Sample 142 is from 1,500 tons of "Specular No. 2" ("Essex"); texture of ore, compact.

d



e

FIG. 186.—PLAN OF THE NEW YORK MINE, MARQUETTE COUNTY, MICHIGAN.

(5) *Barnum.*—On Sec. 9, T. 47, R. 27, adjoining Lake Superior mine. First shipment in 1868. Total product, f 514,259 tons. Product in census year, 28,000 tons. Operated by the Iron Cliff Company. A sample of the ore collected at Cleveland by Mr. Willis, from 2,000 tons of specular ore, contained—

	129.		129.
	Per cent.		*Per cent.*
Metallic iron	63.45	Titanic acid	Absent.
Phosphorus	0.096	Insoluble silicious matter	7.12
Sulphur	0.011	Phosphoric acid	0.219
Silica	5.47	Phosphorus in 100 parts iron	0.151
Alumina	2.41	Specific gravity	4.946
Manganese	Absent.	Per cent. iron divided by specific gravity	12.82

Texture of ore, compact.

a These figures include the product of the Lake Superior hematite and the Lowthian mines. (See under soft hematites.)

(6) *Lake Angeline.*—On N. ½ Sec. 15, T. 47, R. 27, on south shore of lake Angeline. First shipment in 1864. Total product, 568,553(*a*) tons. Product in census year, 16,719(*a*) tons. Operated by the Pittsburgh and Lake Angeline Iron Company. The ore in this mine is chiefly a silicious or "No. 2" specular. On the north side of the pit there is a hematite schist of unknown thickness; although containing more than 40 per cent. metallic iron, this is not at present considered an ore. A pocket of fair quality "soft hematite," resembling the Salisbury ore, has recently been uncovered in the western end of the pit, lying in the hard ore. The samples collected contained—

	11.	12.	13.	108.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	55.11	53.85	42.27	46.91
Phosphorus	0.007	0.061	0.051	0.031
Sulphur				0.039
Silica				27.72
Alumina				4.15
Manganese				Absent.
Titanic acid				Absent.
Insoluble silicious matter				30.59
Phosphoric acid				0.070
Phosphorus in 100 parts iron	0.013	0.113	0.121	0.066
Specific gravity	4.814	3.829	2.774	4.077
Per cent. iron divided by specific gravity	11.44	14.27	15.23	11.50

Sample No. 11 was taken across the west side of the pump-shaft pillar. The ore is hard and jaspery; texture compact. Sample No. 12 is from the pocket of soft hematite at the western end of the mine; texture, earthy; color, brown. It is probably a mixture of the hydrous and anhydrous oxides. Sample No. 13 is from the north wall of the pit near the pump-shaft pillar. It represents the hematite schist. It probably is not, however, an average sample. Sample No. 108 is from 4,000 tons of specular ore at the North Chicago rolling-mill. This sample was collected by Mr. Willis. It represents an average of the ore of which No. 11 is a special sample.

The location of samples Nos. 11, 12, and 13 is shown on Fig. 187.

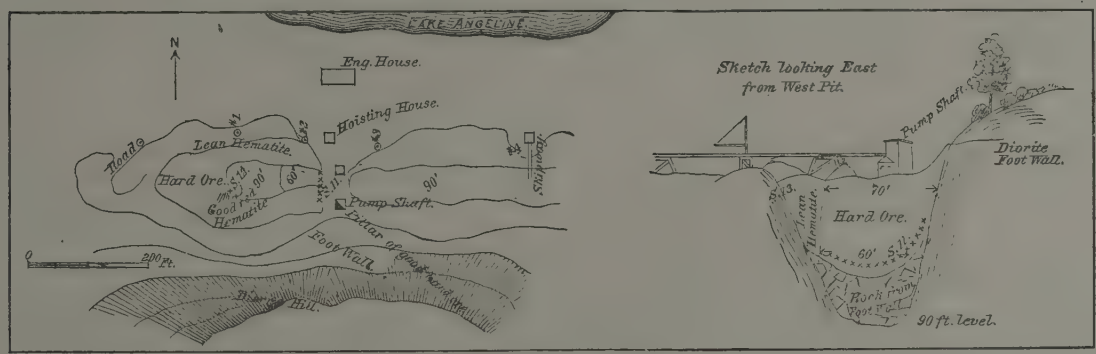


FIG. 187—SKETCH OF THE LAKE ANGELINE MINE, MARQUETTE COUNTY, MICHIGAN.

(7) *National.*—On Sec. 16, T. 47, R. 27. Opened in 1878. Total product, 75,043 tons. Product in census year, 33,600 tons. Owners, Lake Superior Iron Company. Operated by Samuel Mitchell and A. G. Stone. The ore was not sampled.

The SAGINAW RANGE lies about a mile south of the National mine. It includes the following-named mines, arranged in order from east to west: Mitchell, Winthrop, Lowthian, [New England], [Section 19], Saginaw, and Goodrich. The mines the names of which are inclosed in brackets are not now being worked. The first four names on the list produce soft hematite ore, which is considered to belong to Formation XII. The analyses of these ores will be given under "Soft Hematites". Of the other mines of the range, the—

(8) *Saginaw* is on the NW. ¼ of NE. ¼ Sec. 19, T. 47, R. 27. Its first shipment was in 1872. Total product 436,778 tons. Product in census year, 30,240 tons. A sample of the ore, collected at Cleveland by Mr. Willis from 3,000 tons, contained—

	144.		144.
	Per cent.		*Per cent.*
Metallic iron	62.53	Titanic acid	Trace.
Phosphorus	0.106	Insoluble silicious matter	8.68
Sulphur	0.057	Phosphoric acid	0.243
Silica	5.47	Phosphorus in 100 parts iron	0.170
Alumina	2.53	Specific gravity	4.963
Manganese	Absent.	Per cent. iron divided by specific gravity	12.59

Texture of ore, compact.

a Including product of hematite mine on south side of the hill adjoining the Salisbury mine.

a (9) *Goodrich.*—On W. ½ of NW. ¼ Sec. 19, T. 47, R. 27. First shipment in 1872. Total product, 35,124 tons. Product in census year, 6,720 tons. Operated by Captain Goodrich. The ore was not sampled.

The NORTH or CONRAD RANGE has been traced from the Excelsior mine, in the NE. ¼ Sec. 6, T. 47, R. 27, to Michigamme lake. It now includes the following mines: Excelsior, Boston, Sterling, Dalliba, and Northampton.

(10) *Excelsior.*—On SE. ¼ Sec. 16, T. 47, R. 27. First shipment in 1872. Total product, 13,265 tons. Idle in census year. Owned by the Iron Cliff Company. The ore was not sampled.

(11) *Boston.*—On SE. ¼ of SW. ¼ Sec. 32, T. 48, R. 28. Opened in January, 1880. Shipped in 1880, 7,255 tons. Operated by "The Boston mine." A sample of the ore from the stock-pile at the mine was collected by Mr. George A. Fay. It contained—

b

	10.		10.
	Per cent.		*Per cent.*
Sulphur	0.007	Phosphoric acid	0.022
Phosphorus	0.009	Hygroscopic water	0.02
Iron, metallic	66.36	Water of composition	0.65
Phosphorus in 100 parts iron	0.014	Total	100.055
Silica	2.61	Insoluble silicious matter	4.88
Iron, protoxide	1.26		
Iron, peroxide	93.39		
Alumina	1.59	Silica	2.61
Lime	0.04	Alumina	1.84
Iron, disulphide	0.013	Lime	0.04
Potassa	0.31	Potassa	0.31
Soda	0.07	Soda	0.07
Carbonic acid	0.08	Total	4.87

c

(12) *Sterling.*—On SW. ¼ of SW. ¼ Sec. 32, T. 48, R. 28, adjoining the Boston on the west. Operated by Messrs. A. Kidder and J. Outhwaite. Opened in 1880. Total product, 1,341 tons. Samples of the ore collected by Professor Pumpelly contained—

d

	1.	2.	3.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	64.76	64.49	64.98
Phosphorus	0.053	0.039	0.025
Phosphorus in 100 parts iron	0.082	0.060	0.039

No. 1 is an average sample, No. 2 is a special sample of the granular ore, and No. 3 is a special sample of the slaty ore.

The *Dalliba*, on the N. ½ of SW. ¼ Sec. 29, T. 48, R. 29, owned by the Dalliba Iron Company, and the *Northampton*, e on SE. ¼ Sec. 30, T. 48, R. 29, owned by the Champion Iron Company, are both new openings. The ore is reported to average over 60 per cent. metallic iron, but to contain too much phosphorus for Bessemer. It was not sampled.

Mines producing ore of Class II (magnetic and slate).

Beginning at the east, the first mine belonging to this class is the Humboldt, although recent explorations by the Conrad Iron Company may result in the development of a mine on the NW. ¼ of NW. ¼ Sec. 18, T. 47, R. 28.

(1) *Humboldt* (formerly Washington).—On NE. ¼ of Sec. 11, T. 47, R. 29; owned by the Washington Iron Company; operated by the Humboldt Iron Company. First shipment in 1865. Total product, 514,298 tons. Product in census year, 17,321 tons. A sample of the magnetic ore, collected by Mr. Willis from a pile of 4,000 tons, contained—

f

	120.		120.
	Per cent.		*Per cent.*
Metallic iron	63.79	Titanic acid	Absent.
Phosphorus	0.154	Insoluble silicious matter	8.12
Sulphur	0.005	Phosphoric acid	0.352
Silica	7.61	Phosphorus in 100 parts iron	0.241
Alumina	2.34	Specific gravity	4.851
Manganese	Slight indication.	Per cent. iron divided by specific gravity	13.14

Texture of ore, granular.

(2) *Edwards*, contiguous to the Humboldt on the west. First shipment in 1866. Total product, 250,912 tons. Mine has been idle since 1879, but is soon to be reopened by the Argyle Iron Mining Company.

Samples of the ore collected by Mr. Willis from old stock-piles at Cleveland contained— a

	132.	133.		132.	133.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	59.89	60.02	Titanic acid	Present.	Present.
Phosphorus	0.072	0.107	Insoluble silicious matter	11.52	11.10
Sulphur	0.096	0.199	Phosphoric acid	0.162	0.246
Silica	7.98	6.30	Phosphorus in 100 parts iron	0.120	0.178
Alumina	5.06	4.08	Specific gravity	4.726	4.739
Manganese	Present.	Absent.	Per cent. iron divided by specific gravity	12.65	12.66

b

Sample No. 132 is from 1,000 tons of magnetic ore; texture of ore, granular. Sample No. 133 is from 1,000 tons of specular slate ore; texture of ore, micaceous.

(3) *Champion.*—On S. ½ Sec. 31, T. 48, R. 29. Operated by the Champion Iron Company. First shipment in 1868. Total product, 929,220 tons. Product in census year, 99,609 tons. Samples of the ore collected at Cleveland by Mr. Willis contained—

	103.	104.	130.	147.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	64.01	60.70	59.17	66.75
Phosphorus	0.039	0.044	0.035	0.038
Sulphur	0.099	0.064	.....	0.085
Silica	4.92	6.29	8.03	2.60
Alumina	3.15	6.08	5.35	1.90
Manganese	Absent.	Present.	Absent.	Present.
Titanic acid	Absent.	0.07	Absent.	Absent.
Insoluble silicious matter	7.36	9.84	12.29	3.94
Phosphoric acid	0.089	0.100	0.082	0.088
Phosphorus in 100 parts iron	0.060	0.073	0.059	0.057
Specific gravity	4.668	4.523	4.635	.....
Per cent. iron divided by specific gravity	13.71	13.42	12.76	.....

c d

Sample No. 103 is from a pile of 7,000 tons of magnetic No. 1; texture of ore, granular. Sample No. 104 is from a pile of 4,000 tons of "Chelsea" or No. 2 ore; it is a mixture of magnetic and specular ores; texture, granular and micaceous. Sample No. 130 is from a pile of 1,500 tons of "Beacon" or "specular and magnetic No. 2"; texture of ore, micaceous and granular. Sample No. 147 is a special sample of the fine ore in the pile from which sample No. 103 was taken (see under sample No. 150, Jackson mine, p. 425); texture of ore, granular.

The presence of titanic acid in sample No. 104 is noticeable. As it has been repeatedly stated that this element was absent from all the ores of the Marquette region. It has, however, been found also in the ore from the Keystone mine (samples Nos. 127 and 143) and the Edwards mine (samples Nos. 132 and 133).

(4) *Keystone.*—On SW. ¼ of SW. ¼ Sec. 32, T. 48, R. 29. Operated by the Keystone Iron Company; first shipment e in 1872. Total product, 70,326. Product in census year, 10,080 tons. Samples of the ore collected at Cleveland by Mr. Willis contained—

	127.	143.		127.	143.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Sulphur	0.102	0.055	Phosphoric acid	1.256	0.720
Phosphorus	0.548	0.314	Titanic acid	0.012	0.49
Iron, metallic	60.05	59.17	Carbon and carbonaceous matter	.....	0.12
Phosphorus in 100 parts iron	0.913	0.530	Hygroscopic water	.....	0.28
Specific gravity	4.567	4.597	Water of composition	.....	0.23
Per cent. iron divided by specific gravity	13.14	12.90	Total	.....	100.043
Silica	6.69	7.61	Insoluble silicious matter	9.910	11.61
Iron, protoxide	.....	11.36			
Iron, peroxide	.....	71.88	Silica	.....	7.61
Alumina	3.59	3.45	Alumina	.....	2.48
Manganese, protoxide	Absent.	0.04	Lime	.....	0.09
Lime	.....	1.34	Magnesia	.....	0.11
Magnesia	.....	0.56	Potassa	.....	0.54
Iron, disulphide	.....	0.083	Soda	.....	0.65
Potassa	.....	0.92	Phosphoric acid	.....	0.147
Soda	.....	0.86			
Carbonic acid	.....	0.10	Total	.....	11.627

f

a Sample No. 127 is from a pile of 1,000 tons of ore "shipped in 1878 from a drift, since abandoned on account of the poor quality of the ore". Sample No. 143 is from 3,000 tons of ore at "The River furnaces" of the Cleveland Rolling-Mill Company. Sample No. 127 contains a higher per cent. of phosphorus than any other ore from the upper peninsula, the analysis of which has been published. The presence of titanic acid is also noticeable.

(5) *Michigamme.*—On north side of lake Michigamme, on S. ½ of Secs. 19 and 20, T. 48, R. 30. Operated by the Michigamme Iron Company. First shipment in 1872. Total product, 432,200 tons. Product in census year, 66,158 tons. The ore is all granular magnetite. Samples collected at the mine contained—

b

	1.	2.	3.	4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sulphur	0.103	0.237	0.068	0.027
Phosphorus	0.095	0.092	0.042	0.053
Iron, metallic	63.55	56.35	59.95	65.24
Phosphorus in 100 parts iron	0.149	0.163	0.070	0.081
Specific gravity	4.696 4.621	4.801 3.852	4.659	4.865
Per cent. iron divided by specific gravity	13.64	13.02	12.86	13.41
Silica	5.24	15.14	13.75	5.78
Iron, protoxide	28.52	.....	.....	29.94
Iron, peroxide	58.99	.....	.....	59.89
Alumina	2.95	.....	.....	2.20
Manganese	0.34	Present.	Present.	0.16
Lime	0.94	.....	.....	0.27
Magnesia	0.78	.....	.....	0.63
Iron, disulphide	0.193	.....	.....	0.051
Carbonic acid	1.10	.....	.....	0.17
Phosphoric acid	0.217	0.211	0.096	0.121
Carbon in carbonaceous matter	0.05	.....	.....	.....
Hygroscopic water	0.04	.....	.....	0.02
Water of composition	0.72	.....	.....	0.88
Total	100.380	.....	.....	100.112
Insoluble silicious matter	6.24	.....	.....	6.11
Silica	5.24	.....	.....	5.78
Alumina	0.80	.....	.....	0.34
Magnesia	0.19	.....	.....	.....
Total	6.23	.....	.....	6.12

c

d

Sample No. 1 was taken across the stope in pit No. 4, fourth level, about 375 feet below surface and 130 feet east of shaft. The stope is 25 feet wide. Sample No. 2 is also from pit No. 4, first level, 375 feet east of shaft. This e pit is very wet, and part of the ore as it comes from the mine is covered with a coating of red oxide. Sample No. 3 is from pit No. 1, second level, 130 feet below surface and 140 feet west of shaft. The stope is 15 feet wide.

Pit No. 1 is about 900 feet east of pit No. 4; 100 feet west of pit No. 1 a shaft is (November, 1879) being sunk on a lens of ore recently discovered. The shaft is 35 feet deep. The ore, which at the bottom of the shaft is 9 feet wide, is represented by sample No. 4.

The greater part of the ore shipped in the census year was mined in pit No. 4, but some ore was raised from both pits Nos. 5 and 6, which are west of No. 4. The samples of the ore collected by Mr. Willis contained—

f

	110.	148.		110.	148.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	61.95	60.98	Titanic acid	Absent.	Absent.
Phosphorus	0.118	0.101	Insoluble silicious matter	8.28	8.25
Sulphur	0.109	0.261	Phosphoric acid	0.272	0.232
Silica	7.09	7.60	Phosphorus in 100 parts iron	0.190	0.166
Alumina	1.98	2.96	Specific gravity	4.568	.....
Manganese	Present.	Present.	Per cent. iron divided by specific gravity	13.53	.....

Sample No. 110 represents an average of a pile of 4,500 tons of ore at the North Chicago rolling-mill. Sample No. 148 is a special sample of the fine ore in the same pile (see note under sample No. 150, Jackson mine, page 425.)

(6) *Spurr Mountain.*—On SW. ¼ of NW. ¼ Sec. 24, T. 48, R. 31. First shipment in 1872. Total product, a 160,724 tons. Idle since 1878. A sample of the ore collected by Mr. Willis at Cleveland, from an old stock-pile of 800 tons, contained—

	121.		121.
	Per cent.		*Per cent.*
Metallic iron	62.21	Titanic acid	Absent.
Phosphorus	0.114	Insoluble silicious matter	7.39
Sulphur	0.016	Phosphorus in 100 parts iron	0.183
Silica	6.91	Specific gravity	4.564
Alumina	2.88	Per cent. iron divided by specific gravity	13.63
Manganese	Trace.		

b

The ore is a granular magnetite.

(7) *Steward.*—On Sec. 23, T. 48, R. 31, west of Spurr mountain. First shipment in 1874. Total product, 3,335 tons. Idle since 1878. The ore was not sampled.

(8) *Republic.*—On Sec. 7, T. 46, R. 29. Operated by the Republic Iron Company. First shipment in 1872 Total product, 1,334,517 tons. Product in census year, 224,000 tons. The samples of the ore collected at the mine contained— c

	5.	7.	8.	9.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sulphur	0.037	0.050	.....	.....
Phosphorus	0.024	0.051	0.061	0.033
Iron, metallic	67.02	69.62	64.01	68.17
Phosphorus in 100 parts iron	0.036	0.073	0.095	0.048
Specific gravity	5.118	5.071	4.136	4.639
Per cent. iron divided by specific gravity	13.10	13.74	15.5	14.7
Silica	3.38	1.41	.....	.....
Iron, protoxide	1.05	20.87	.....	.....
Iron, peroxide	94.58	76.27	.....	.....
Alumina	0.38	0.52	.....	.....
Lime	0.03	0.13	.....	.....
Magnesia	0.33	0.25	.....	.....
Iron, disulphide	0.067	0.094	.....	.....
Carbonic acid	0.08	0.05	.....	.....
Phosphoric acid	0.055	0.117	.....	.....
Carbon in carbonaceous matter	.....	0.01	.....	.....
Hygroscopic water	.....	0.10	.....	.....
Water of composition	0.14	0.20	.....	.....
Total	100.092	100.021	.....	.....
Insoluble silicious matter	3.59	1.79	.....	.....
Silica	3.38	1.41	.....	.....
Alumina (with a trace of oxide of iron)	0.21	0.40	.....	.....
Total	3.59	1.81	.....	.....

d

e

In pit No. 5 an approximate section across the north side of the pillar, 70 feet south from the shaft and 200 feet below surface, shows: 1st, 80 feet of micaceous specular slate ore; 2d, 40 feet of chloritic schist; and 3d, 30 feet of granular magnetite. The latter is next the quartzite (hanging wall). The chloritic schist is lens-shaped and pitches toward the north. At a higher level the magnetic and specular ores are almost in direct contact. f Magnetic ore has been found only in pits Nos. 3 to 6, which are all connected and form practically one pit. In 1879 the total product of the Republic mine was 151,369 tons. Of this amount, 16,952 tons was magnetic ore; the balance was micaceous specular.

Sample No. 5 was taken across the exposure of specular ore in pit No. 5, 200 feet below surface. Sample No. 7 was taken across the exposure of magnetic ore in the same pillar, but at the 250-foot level. Sample No. 8 was taken across the stope in the Morgan pit, 135 feet below surface (on the incline, 60°), and 80 feet east of shaft. The stope is about 60 feet wide. The ore is all micaceous specular. Sample No. 9 was taken in the Ely pit across the stope 75 feet east of shaft, on the 200-foot level. The character of the ore is the same as that of samples Nos. 5 and 8.

a The following analyses are of samples of the ore collected by Mr. Willis at Cleveland:

	101.	145.	102.	146.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	64.81	67.03	67.52	69.13
Phosphorus	0.050	0.042	0.081	0.062
Sulphur	0.053	0.054	0.008	0.022
Silica	4.62	2.33	2.78	1.60
Alumina	1.92	1.30	2.03	1.09
Manganese	Trace.	Absent.	Absent.	Absent.
Titanic acid	Absent.	Absent.	Absent.	Absent.
Insoluble silicious matter	5.86	3.05	4.61	2.69
Phosphorus in 100 parts iron	0.077	0.062	0.120	0.090
Specific gravity	4.872	.....	4.917	.....
Per cent. iron divided by specific gravity	13.30	.....	13.73	.....

b

Sample No. 101 is an average of a pile of 25,000 tons of first-class micaceous specular ore. Sample No. 145 is a special sample of the fine ore in the same pile (see note to sample No. 150, Jackson mine, 425). Sample No. 102 is an average of a pile of 600 tons of magnetic ore. Sample No. 146 is a special sample of the fine magnetic c ore. A little second class or No. 2 ore is shipped from the mine, but it was not sampled.

(8) *Kloman* (now *Columbia*).—On the extension of the east side of Republic trough, north of Michigamme river. First shipment in 1873. Total product, 78,748 tons. Mine was idle from 1875 to 1880. Reopened in the latter year by the Columbia Iron Company. The ore was not sampled.

Mines producing ore of Class III (soft hematite).

(*a*) The mines in bed X can, geographically, be grouped into the Negaunee range, Teal Lake range, and Salisbury range.

NEGAUNEE RANGE.—The mines included in this range, with the exception of the South Jackson and Section d 12, all lie in the NW. part of T. 47, R. 26.

(1) *Rowland*.—On W. ½ of Sec. 17, near west section line. Owned by the Iron Cliff Company. Opened in 1872, but not worked steadily. Total product, exclusive of ore used in company's furnaces, 3,358 tons.

(2) *Indiana* (formerly *Green Bay*).—On W. ½ of NW. ¼ Sec. 8. Operated by Blake & Allen. Total product, 16,214 tons.

(3) *Rolling Mill* (sometimes called *Berringer*).—On S. ½ of NE. ¼ Sec. 7. Operated by Captain Berringer. First shipment in 1871. Total product, 239,718 tons. Product in census year, 14,156 tons.

A sample of the ore collected at Cleveland by Mr. Willis from 4,000 tons contained—

e

	136.		136.
	Per cent.		*Per cent.*
Metallic iron	47.13	Titanic acid	Absent.
Phosphorus	0.033	Insoluble silicious matter	28.34
Sulphur	0.066	Phosphoric acid	0.077
Silica	27.99	Phosphorus in 100 parts iron	0.070
Alumina	1.65	Specific gravity	3.996
Manganese	Present.	Per cent. iron divided by specific gravity	11.79

Texture of ore, earthy.

(4) *Baraga*.—On SE. ¼ of SE. ¼ Sec. 6. Operated by the Baraga Iron Company. It is a new opening; no ore was shipped previous to the end of 1880.

f (5) *Orion* (formerly the *Himrod Hematite*).—On N. ½ SE. ¼ Sec. 6. Product in 1879, 561 tons. Not reported on census schedules.

(6) *New York Hematite* (formerly the *Grand Central*).—On E. ½ of SW. ¼ Sec. 6. Operated by Neely & Sweeney. First shipment in 1870. Total product, 39,504 tons. Product in census year, 2,240 tons.

(7) *Pendill*.—On W. ½ of SW. ¼ Sec. 6. Operated by the Union Mining Company. Opened in 1877. The mine was worked in 1879 by the McComber Iron Company, and its output for that year is included in the total product of the McComber mine. The total production of the Pendill mine cannot, therefore, be given. Its product in the census year was 20,160 tons.

(8) *Chicago* (formerly the *Calhoun and Spurr*).—On S. ½ of SE. ¼, Sec. 7. Operated by J. F. Stevens and W. C. Calhoun. First shipment in 1880. Total product, 3,768 tons. Product in census year, 3,304 tons.

(9) *Manganese* (formerly the *Negaunee*).—On NE. ¼ of NW. ¼ of Sec. 7. Operated by J. W. Schodt. First a shipment in 1871. Total product, 30,892 tons. Product in census year, 11,200 tons. The mine was idle from 1873 to 1877 (both years inclusive). A sample collected at Cleveland, by Mr. Willis, from 1,200 tons of the ore, contained—

	112.		112.
	Per cent.		*Per cent.*
Metallic iron	41.54	Titanic acid	Absent.
Phosphorus	0.077	Insoluble silicious matter	25.10
Sulphur	.....	Phosphoric acid	0.177
Silica	23.89	Phosphorus in 100 parts iron	0.185
Alumina	3.00	Specific gravity	4.296
Manganese	Present.	Per cent. iron divided by specific gravity	9.66

b

Texture of ore, earthy.

(10) *Milwaukee.*—On SE. ¼ of NE. ¼ Sec. 7. Operated by J. Q. Adams and James F. Foley. First shipment in 1879. Total product, 15,773 tons. Product in census year, 3,360 tons.

(11) *McComber.*—On NW. ¼ of NW. ¼ Sec. 7. Operated by the McComber Iron Company. First shipment in 1870. Total product, 251,229 tons. Product in census year, 33,600 tons. Samples of the ore yielded, on analysis—

c

	85.	86.	87.	111.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Sulphur	.....	0.040	0.010	0.155
Phosphorus	0.090	0.028	0.026	0.058
Iron, metallic	54.85	59.27	55.47	52.43
Phosphorus in 100 parts iron	0.164	0.047	0.046	0.111
Specific gravity	4.049	4.329	4.575	4.044
Per cent. iron divided by specific gravity	.....	.....	12.00	.....
Silica	.....	5.31	4.04	12.61
Iron, peroxide	.....	84.63	79.23	.....
Alumina	.....	3.57	3.04	2.88
Manganese, protoxide	0.11	0.44	1.36	Present.
Manganese, dioxide	.....	0.11	8.23	.....
Lime	.....	0.15	0.11	.....
Magnesia	.....	0.12	0.14	.....
Iron, disulphide	.....	0.075	0.019	.....
Potassa	.....	0.02	0.15	.....
Soda	.....	.....	0.01	.....
Carbonic acid	.....	0.13	0.11	.....
Phosphoric acid	.....	0.065	0.060	0.132
Barium oxide	.....	.....	0.11	.....
Hygroscopic water	.....	0.27	0.60	.....
Water of composition	.....	5.19	2.90	.....
Total	.....	100.070	100.109	.....
Insoluble silicious matter	.....	7.92	5.97	15.19
Silica	.....	5.30	4.04	.....
Alumina	.....	2.55	1.68	.....
Lime	.....	0.01	0.01	.....
Magnesia	.....	0.01	0.07	.....
Potassa	.....	0.02	0.15	.....
Soda	.....	.....	0.01	.....
Total	.....	7.90	5.96	.....

d

e

f

At the southern end of pit No. 5, in which most of the ore shipped in the census year was mined, a section across the stope shows 6 feet of a soft, reddish-brown ore on the north, and 14 feet of a harder and darker-colored ore on the south. Sample No. 85 represents the hard ore, and sample No. 86 the soft ore. Sample No. 87 is from the bottom of shaft No. 6, a new opening west of the engine-house. The shaft is about 130 feet deep. The ore at the bottom of the shaft is 19 feet wide. Sample No. 111 was collected by Mr. Willis, at Cleveland, from a pile of 1,500 tons.

a (12) *South Jackson.*—On SE. ¼ Sec. 1, T. 47, R. 27, west of the McComber. Operated by the Jackson Iron Company. The shipments of ore are included with those of the Jackson mine. Samples collected by Mr. Willis, at Cleveland, contained—

b

	137.	138.		137.	138.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	61.71	54.88	Titanic acid	Absent.	Absent.
Phosphorus	0.140	0.096	Insoluble silicious matter	4.82	12.40
Sulphur	0.078	0.093	Phosphoric acid	0.322	0.220
Silica	3.77	11.17	Phosphorus in 100 parts iron	0.227	0.175
Alumina	1.75	2.40	Specific gravity	4.488	4.475
Manganese	Present.	Present.	Per cent. iron divided by specific gravity	13.75	12.26

Sample No. 137 is from 2,000 tons of "Jackson West", or "soft specular". The ore "is porous, stalactitic, and contains mammillary crystals". In mass its texture is earthy. Sample No. 138 is from 6,000 tons of "Jackson, southside hematite". Texture of ore, earthy.

(13) *Section 12 mine.*—On NE. ¼ Sec. 12, T. 47, R. 27, contiguous with one pit of the South Jackson. Owned by the Iron Cliff Company. Opened in 1879. Product in census year, 6,720 tons.

c The TEAL LAKE RANGE range extends along the south side of Teal lake, about 1½ mile northwest of Negaunee. Beginning at the east, the first mine on the range is the—

(14) *Cambria.*—On SE. ¼ Sec. 35, T. 48, R. 27. Opened in 1874. Total product, 38,368 tons. Product in census year, 6,720 tons. The mine is leased by the Cambria Mining Company. A sample of the ore collected at Cleveland, by Mr. Willis, from a pile of 3,000 tons, contained:

d

	124.		124.
	Per cent.		*Per cent.*
Metallic iron	49.05	Titanic acid	0.07
Phosphorus	0.063	Insoluble silicious matter	23.00
Sulphur	0.043	Phosphoric acid	0.146
Silica	21.83	Phosphorus in 100 parts iron	0.128
Alumina	2.70	Specific gravity	3.722
Manganese	Absent.	Per cent. iron divided by specific gravity	13.2

(15) *Bessemer.*—Adjoins the Cambria on the west, on the same section. Opened in 1876. Total product, 73,479 tons. Product in census year, 24,640 tons. Operated by J. H. King and C. M. Wheeler. A sample of the ore collected at Cleveland, by Mr. Willis, from a pile of 1,000 tons, contained—

e

	116.		116.
	Per cent.		*Per cent.*
Metallic iron	57.52	Titanic acid	Absent.
Phosphorus	0.082	Insoluble silicious matter	10.80
Sulphur	0.059	Phosphoric acid	0.186
Silica	8.55	Phosphorus in 100 parts iron	0.143
Alumina	2.70	Specific gravity	3.765
Manganese	Present.	Per cent. iron divided by specific gravity	15.3

(16) *Forest City.*—Also on Sec. 35. Recently opened by the Forest City Iron Company. No ore has yet been shipped.

(17) *Cleveland Hematite* (now called the *Nelson*).—On NW. ¼ Sec. 2, T. 47, R. 27. Opened in 1876. Total product, f 54,914 tons. Product in census year, 18,729 tons. Leased by Robert Nelson.

A sample of the ore collected at Cleveland, by Mr. Willis, from a pile of 5,000 tons, contained—

	122.		122.
	Per cent.		*Per cent.*
Metallic iron	59.34	Titanic acid	Absent.
Phosphorus	0.056	Insoluble silicious matter	9.12
Sulphur	0.057	Phosphoric acid	0.128
Silica	7.23	Phosphorus in 100 parts iron	0.094
Alumina	3.04	Specific gravity	4.727
Manganese	Present.	Per cent. iron divided by specific gravity	13.1

The SALISBURY RANGE. (18) *Foster.*—On SW. ¼ Sec. 23, T. 47, R. 27. Operated by the Iron Cliff Company. a First shipment in 1860. Total product, 118,748 tons.

(19) *Salisbury.*—On N. ½ Sec. 15, T. 47, R. 27. Operated by the Iron Cliff Company. Total product, 219,026 tons. Product in census year, 28,000 tons. Samples of the ore contained—

	14.	15.	109.		14.	15.	109.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	61.97	61.90	59.95	Insoluble silicious matter			6.55
Phosphorus	0.047	0.188	0.128	Phosphoric acid			0.294
Sulphur			0.055	Phosphorus in 100 parts iron	0.076	0.304	0.214 b
Silica			5.18	Specific gravity	3.895		
Alumina			3.43		4.370	4.592	4.011
Manganese			Present.	Per cent. iron divided by specific gravity	14.99	13.48	14.94
Titanic acid			Absent.				

Sample No. 14 was taken across the stope in the open pit, 90 feet below surface (see Fig. 188). Sample No.

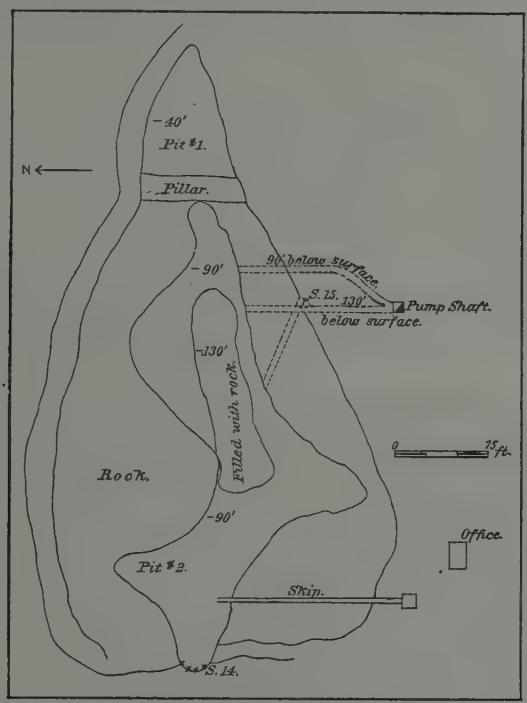


FIG. 188.—SKETCH PLAN OF THE SALISBURY MINE, MARQUETTE COUNTY, MICHIGAN.

15 was taken in one of the drifts, 130 feet below the surface. The drift was very wet. Sample No. 109 was taken by Mr. Willis from a pile of 4,000 tons of ore at Cleveland.

The Pittsburgh and Lake Angeline Iron Company are working a small pit adjoining the Salisbury mine on the west. The ore is similar to the Salisbury ore.

The soft hematite mines belonging to BED XII are the Lake Superior Hematite, Mitchell, Winthrop, and f Lowthian.

(20) *Lake Superior Hematite.*—Adjoins the main Lake Superior workings on the south. It is the largest body of soft hematite thus far discovered in the upper peninsula.

A sample of the ore, collected at Cleveland by Mr. Willis from a pile of 3,000 tons, contained—

	126.		126.
	Per cent.		*Per cent.*
Metallic iron	59.94	Titanic acid	Absent.
Phosphorus	0.064	Insoluble silicious matter	7.74
Sulphur	0.003	Phosphoric acid	0.147
Silica	6.26	Phosphorus in 100 parts iron	0.107
Alumina	1.64	Specific gravity	3.975
Manganese	Present.	Per cent. iron divided by specific gravity	15.1

a (21) *Mitchell* (formerly the *Shenango*).—On Secs. 21 and 28, T. 47, R. 27. Leased by the Mitchell Iron Company. Opened in 1872. Total product, 60,961 tons. Product in census year, 17,920 tons.

(22) *Winthrop.*—On SW. ¼ Sec. 21, T. 47, R. 27. Leased by the Winthrop Hematite Company. Opened in 1870. Total product, 238,190 tons. Product in census year, 47,167 tons.

Samples of the ore, collected at Cleveland by Mr. Willis, contained:

b

	105.	106.		105.	106.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	50.54	49.45	Titanic acid	Absent.	Absent.
Phosphorus	0.043	0.053	Insoluble silicious matter	24.79	26.41
Sulphur	0.055	0.045	Phosphoric acid	0.102	0.121
Silica	23.66	25.25	Phosphorus in 100 parts iron	0.085	0.107
Alumina	1.66	1.94	Specific gravity	4.065	.....
Manganese	Present.	Present.	Per cent. iron divided by specific gravity	12.4	.....

Sample 105 is from a pile of 1,000 tons from the "East Winthrop" pit. Sample 106 is from 2,000 tons of "Standard Winthrop" ore.

(23) *Lowthian.*—On Sec. 20, T. 47, R. 27. Owned by the Lake Superior Iron Company. The product is included c with that of the Lake Superior mine.

A sample of the ore, collected at Cleveland by Mr. Willis from 3,000 tons, contained—

d

	128.		128.
	Per cent.		*Per cent.*
Metallic iron	56.27	Titanic acid	Absent.
Phosphorus	0.086	Insoluble silicious matter	14.56
Sulphur	0.078	Phosphoric acid	0.198
Silica	14.19	Phosphorus in 100 parts iron	0.153
Alumina	0.12	Specific gravity	4.104
Manganese	Present.	Per cent. iron divided by specific gravity	13.7

Mines producing ore of Class IV (flag ore).

The ores of this class belong to an horizon below bed V. The only mines that have shipped this ore are in the so-called Cascade range, which lies about 4 miles south of Negaunee. They are the Gribben, Carr, Wheat, Pittsburgh and Lake Superior, and Palmer.

(1) *Gribben.*—Opened in 1872. Total product, 4,031 tons. It has been idle since 1873.

(2) *Carr.*—Opened in 1872. Total product, 2,666 tons. Abandoned in 1874.

(3) *Pittsburgh and Lake Superior* (now a part of the *Palmer*).—Opened in 1872. Idle in 1875 and 1876. Total e product, 29,144 tons. Product in census year, 981 tons.

(4) *Wheat* (formerly *Home*).—Opened in 1873. Operated by the Wheat Iron Company. Idle from 1875 to 1878 (both years inclusive); reopened in 1879. Total product, 8,292 tons.

(5) *Palmer.*—Adjoining the Wheat on the west. On Sec. 31, T. 47, R. 26. Opened in 1871. Total product, 232,987 tons. Product in census year, 33,508 tons.

A sample of the ore, collected at Cleveland by Mr. Willis from 8,000 tons, contained—

f

	118.		118.
	Per cent.		*Per cent.*
Metallic iron	58.67	Titanic acid	Absent.
Phosphorus	0.066	Insoluble silicious matter	11.38
Sulphur	0.038	Phosphoric acid	0.151
Silica	8.08	Phosphorus in 100 parts iron	0.112
Alumina	5.50	Specific gravity	4.527
Manganese	Absent.	Per cent. iron divided by specific gravity	12.8

The Magnetic, Cannon, and Chippeway mines, all in T. 47, R. 30, are described by Mr. Brooks in the *Geological Survey of Michigan*, Vol. I. He supposes the ore to belong to the same horizon as the Cascade Range ores. No shipments have been made from these mines.

There remain to be mentioned, to complete the list of mines in the Marquette region, the Cheshire and the the Taylor mines.

Cheshire (formerly the *Silas C. Smith*).—On SE. ¼ Sec. 18, T. 45, R. 25. Opened in 1872. Operated by the a Cheshire Iron Company. Total product, 89,125 tons. Product in census year, 20,582 tons. The ore is a soft, blue hematite resembling the Menominee Range ores more than the soft ores of the Marquette region. Its geological horizon has not yet been definitely determined. A sample of the ore collected at Cleveland, by Mr. Willis, from 2,000 tons, contained—

	123.		122.
	Per cent.		*Per cent.*
Metallic iron	58.69	Titanic acid	Absent.
Phosphorus	0.053	Insoluble silicious matter	9.14
Sulphur	0.083	Phosphoric acid	0.121
Silica	6.59	Phosphorus in 100 parts iron	0.090
Alumina	1.24	Specific gravity	4.673
Manganese	Present.	Per cent. iron divided by specific gravity	12.8

b

Taylor.—On NW. ¼ Sec. 9, T. 49, R. 33. In the so-called L'Anse range, 10 miles southeast of L'Anse. The Taylor Iron Company hold the lease of the property. The ore is a soft, brown hematite. Its existence has been known for several years, but the first shipment was made in 1880, after the close of the census year. One thousand two hundred and forty-three tons of ore were shipped during the season. The ore was not sampled.

c

THE MENOMINEE IRON REGION.

This region embraces the deposits of iron ore in the southern part of the upper peninsula of Michigan, and also those in the northern portion of Marinette county, Wisconsin. In Michigan there are two belts of iron ore separated by an area of Laurentian granites, gneisses, and schists (see Fig. 184, p. 421). The southern belt extends from near the center of T. 39, R. 28, in a direction a trifle north of west to the Menominee river in T. 40, R. 31, and includes two ranges of ore separated by a belt of silicious marble. Since the completion of the branch of the Chicago and Northwestern railroad to Quinnesec, in 1877, the mines on the southern belt east of that village have been extensively wrought. The railroad was extended in 1879–'80 across the Menominee river to the Florence mine, in T. 40, R. 18, Wisconsin, and the mines west of Quinnesec were opened and made their first shipments of d ore in the summer and autumn of 1880.

Of the *northern belt* comparatively little is known. Ore has been discovered in the southern tier of sections in T. 42, R. 28, 29, and 30, but on account of the want of transportation facilities no developments have as yet (December, 1879) been made. In the *southern belt* the ore consists principally of a soft, specular, blue hematite, which runs high in iron and low in phosphorus. Although quite soft, the ore usually resists hydration and rarely changes color except on handling, when it soon becomes more or less coated with its own red powder. This peculiarity is doubtless due to its physical structure. When examined fresh from the mine the ore is seen to be made up of innumerable fine crystalline particles of specular hematite, which are somewhat loosely agglutinated. On rubbing two pieces together these particles are readily separated and partially reduced to powder. By the time the ore reaches the dock at Cleveland its texture is apparently earthy. e

An ore consisting of a mixture of the red and brown oxides is occasionally met with, however, associated with the blue ore, from which it has evidently been derived. But so far as observed by me this brown ore occurs in quantity only at the Emmet mine, and here the ore-body dips under a swamp. The conditions are therefore exceptional.

Geologically the Michigan (Menominee) ores belong to bed VI (*a*) of Brooks's scheme of the Lower Huronian series. The ore usually occurs in irregular pockets or lens-shaped masses in a banded quartzose ferruginous schist, which is often magnetic, and thus enables the ranges of ore to be traced with the dip-needle. The ore itself does not affect the compass-needle. The region was visited and sampled in December, 1879.

Beginning, as in the Marquette region, at the eastern end, the first mine is the—

(1) *Emmet.*—On NE. ¼ of NE. ¼ Sec. 22, T. 39, R. 28. Operated by the Emmet Mining Company. First shipment f in 1878. Total product, 73,928 tons. Product in census year, 31,447 tons. The workings (see Fig. 190) consist of an open pit about 90 feet long by 50 feet wide and 70 feet deep, the lower diameter of which has a direction nearly east and west, this being the course of the strike of the ore. The latter dips to the south underneath a swamp. The mine is very wet on this account. No rock has thus far been uncovered above the ore, but the latter is overlaid with (1) hard blue clay, (2) shell marl, (3) peat. The thickness of these layers varies considerably; at one point a section showed 3 to 4 feet of clay, 5½ feet of marl, and 3½ feet of peat. A section through the pit is shown in Fig. 190. Both brown and blue ore occur in this pit, and, contrary to what might reasonably be expected on first sight, the blue ore lies *above* the brown, that is, between the latter and the bottom of the swamp. It is evident, however, on closer examination, that the reason for this is to be found in the bed of blue clay above referred to, which has to a great extent prevented the water percolating directly downward, while on the other hand the character of

a Geology of Wisconsin, Vol. III, table facing p. 450 (Brooks), and *Ibid*, p. 679 (Wright).

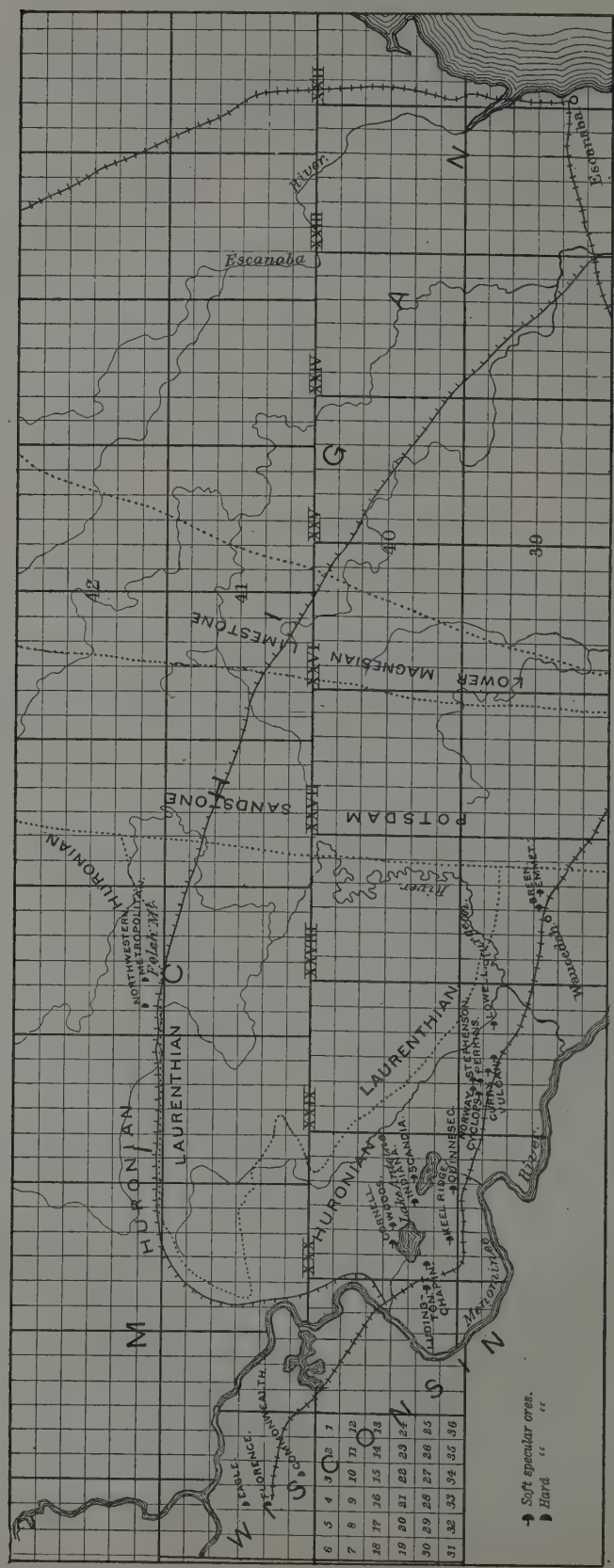


FIG. 189.—MAP OF THE MENOMINEE IRON REGION, MICHIGAN AND WISCONSIN.

the foot-wall rock—a ferruginous silicious schist—has offered no obstacle to the water's reaching the body of ore near it. That the water has drained through this schist is evidenced by the yellow ocher which the latter contains. The samples of ore taken in the pit are compared in the following analyses:

	78.	77.	84.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	50.78	52.97	22.54
Phosphorus	0.103	0.008	0.107
Phosphorus in 100 parts iron	0.204	0.015	0.475

Sample No. 78 represents the brown ore, and sample No. 77 the blue ore. These samples were taken from the stopes in the pit. Sample No. 84 is of the yellow ocher from the foot-wall. By a comparison of these analyses it seems highly probable that the phosphorus in Nos. 78 and 84 has been derived from surface drainage.

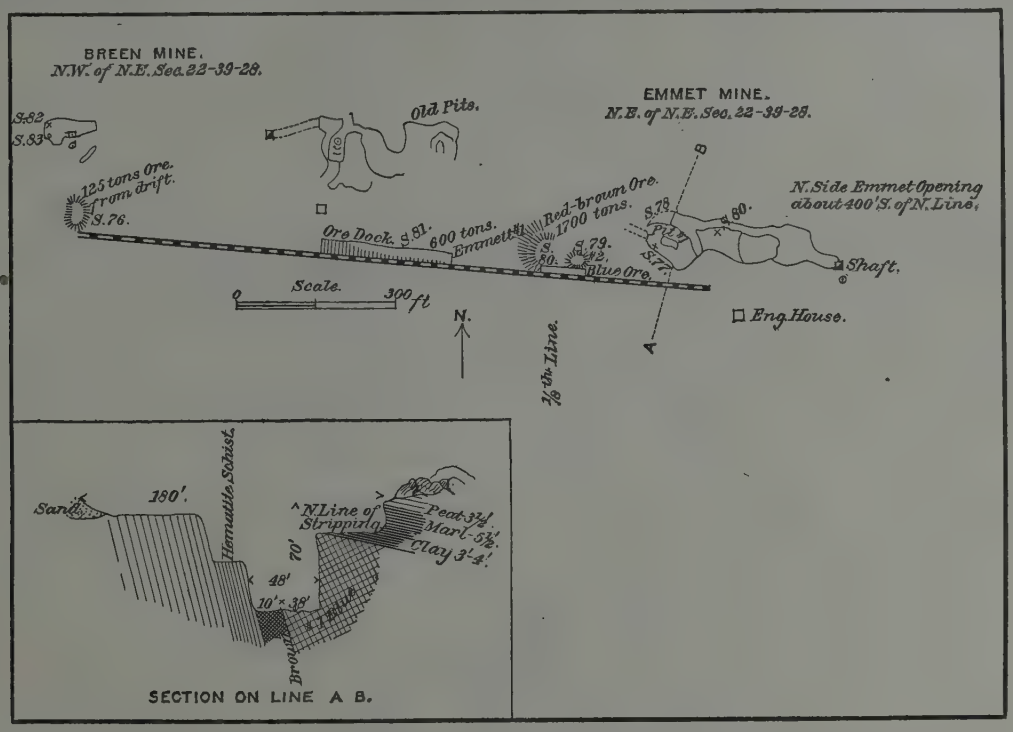


FIG. 190.—SKETCH OF THE EMMET AND BREEN MINES, MENOMINEE COUNTY, MICHIGAN.

Two grades of blue ore are shipped. The following partial analyses are of samples from the stock-piles at the mine:

	81.	79.	80.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	56.07	40.96	42.19
Phosphorus	0.027	0.018	0.076
Phosphorus in 100 parts iron	0.048	0.044	0.180

Sample No. 81 is from 600 tons "No. 1 blue". Sample No. 79 is from 100 tons "No. 2 blue". Sample No. 80 is from 1,700 tons "brown ore". From July 1 to December 18, 1879, the relative amounts of the three grades of ore shipped were as 7 : 7½ : 5. Samples taken by Mr. Willis at Cleveland contained—

	107.	125.		107.	125.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	38.53	47.34	Manganese	Absent.	Present.
Phosphorus	0.058	0.135	Titanic acid	Absent.	Absent.
Sulphur	0.199	0.095	Insoluble silicious matter	41.62	21.76
Silica	40.83	20.95	Phosphorus in 100 parts iron	0.151	0.285
Alumina	1.32	1.68	Specific gravity	4.973	3.814

a Sample No. 107 is from 600 tons "No. 2 blue". Sample No. 125 is from 1,000 tons "brown ore". "No. 1 blue" was not sampled at Cleveland.

(2) *Breen.*—On NW. ¼ of NE. ¼ Sec. 22, T. 39, R. 28, adjoining the Emmet on the west (see Fig. 190). Operated by the Emmet Mining Company. First shipment in 1877. Total product, 19,533 tons. Product in census year, 5,600 tons. The Breen was the first mine opened on the Menominee range. The deposit was not a large one, however, and is now practically exhausted. The workings, as indicated on the sketch, consist of two pits, some 400 feet apart. From the eastern pit, when the mine was visited, a drift was being driven westward in a mixed ore. About one-quarter of the material mined here is sent to the rock-dump, and the balance is shipped, as a second-class ore to the company's furnaces at Sharon, Ohio. Its character is shown by sample No. 76, from a pile of 125 tons.

b Two samples were taken from the breast on the west side of the western pit, although no work was being done here at the time. The ore is of two kinds: Sample No. 82 represents a soft, blue specular ore, which occurs in small seams and pockets between layers of a harder ore having a slaty cleavage. The character of the latter is shown by sample No. 83. Both these samples probably contain more iron than would the average run of the pit. The above samples contained—

c

	76.	82.	83.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	50.17	59.79	53.14
Phosphorus	0.026	0.012	0.005
Phosphorus in 100 parts iron	0.052	0.020	0.009

(3) *East Vulcan* (now called the *Lowell*).—On S. ½ of S. ½ Sec. 11, T. 39, R. 29. Operated by the Menominee Mining Company. First shipment in 1880. Total product, 16,320 tons. The developments on this property in the fall of 1879 are indicated on Fig. 191. A sample of the ore thrown out from the trench and the two shafts contained:

d

	67.
	Per cent.
Metallic iron	58.83
Phosphorus	0.006
Phosphorus in 100 parts iron	0.010

e

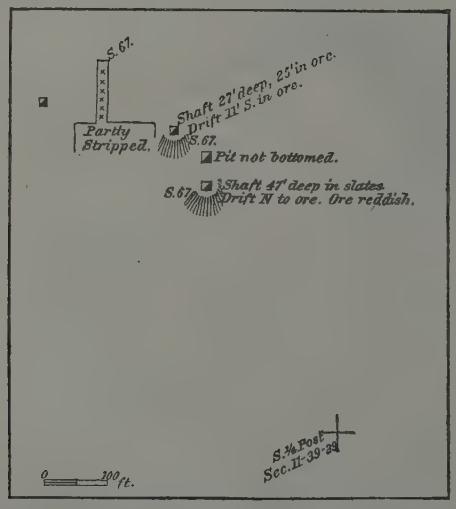


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FIG. 191.—SKETCH PLAN OF THE EAST VULCAN (LOWELL) MINE, MENOMINEE COUNTY, MICHIGAN.

(4) *Vulcan.*—On Secs. 9 and 10, T. 39, R. 29. Operated by the Menominee Mining Company. First shipment in 1877. Total product, 194,294 tons. Product in census year, 83,394 tons. The mine includes two distinct groups of workings (see Fig. 192). The Old Vulcan, or pit No. 1, where the first mining was done, is entered by a tunnel at a point about 40 feet below the original outcrop. The lens of ore dips to the south and pitches westward. With the exception of a small pocket of ore immediately west of the tunnel, the ore-body is worked out down to the tunnel-level. Sample No. 65 was taken from this pocket of ore. The ore is peculiar in that it becomes covered with an ashy-gray coating on exposure to the air. In December, 1879, sinking was progressing at a point near the

south side of the pit and some 40 paces west of the tunnel. At a depth of about 50 feet below the tunnel-level a body of ore 20 to 25 feet wide and 40 to 50 feet long had been uncovered. The character of this ore is indicated by sample No. 66. The above samples contained—.

	65.	66.		65.	66.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	62.89	62.38	Phosphoric acid	0.002	.....
Phosphorus	0.001	0.005	Titanic acid	0.075	.....
Sulphur	0.023	.....	Hygroscopic water	.....	0.10
Phosphorus in 100 parts of iron	0.002	0.008	Water of composition	0.72	.....
			Total	99.990	.....
Silica	6.23	.....			
Iron, protoxide	1.06	.....	Per cent. of insoluble silicious matter	7.31	.....
Iron, peroxide	88.62	.....			
Alumina	1.98	.....	Silica	6.23	.....
Manganese, protoxide	0.02	.....	Alumina	0.72	.....
Lime	0.13	.....	Lime	0.04	.....
Magnesia	0.61	.....	Magnesia	0.05	.....
Iron, disulphide	0.043	.....	Potassa	0.30	.....
Potassa	0.30	.....			
Carbonic acid	0.10	.....	Total	7.34	.....

The presence of titanium in sample No. 65 is noticeable as the Menominee ores, like those in the Marquette region, are usually free from this element.

Pit No. 3, or New Vulcan, is situated about 500 feet northwest of pit No. 1. There are here two openings, connected at the tram-road level by a drift. The eastern opening is about 75 feet long by 25 feet wide, and is entered by a tunnel at about 25 feet below the original outcrop. From the bottom of this opening a shaft has been sunk to a depth of 57 feet on the dip of the ore, which is toward the south, at an angle of about 45°. At the bottom of the shaft a room 20 by 25 feet has been worked out, the width of the ore here being a little more than 20 feet. The ore is a beautiful soft, blue specular, perfectly free from rock intermixture, from hanging- to foot-wall. Its character is shown by sample No. 60.

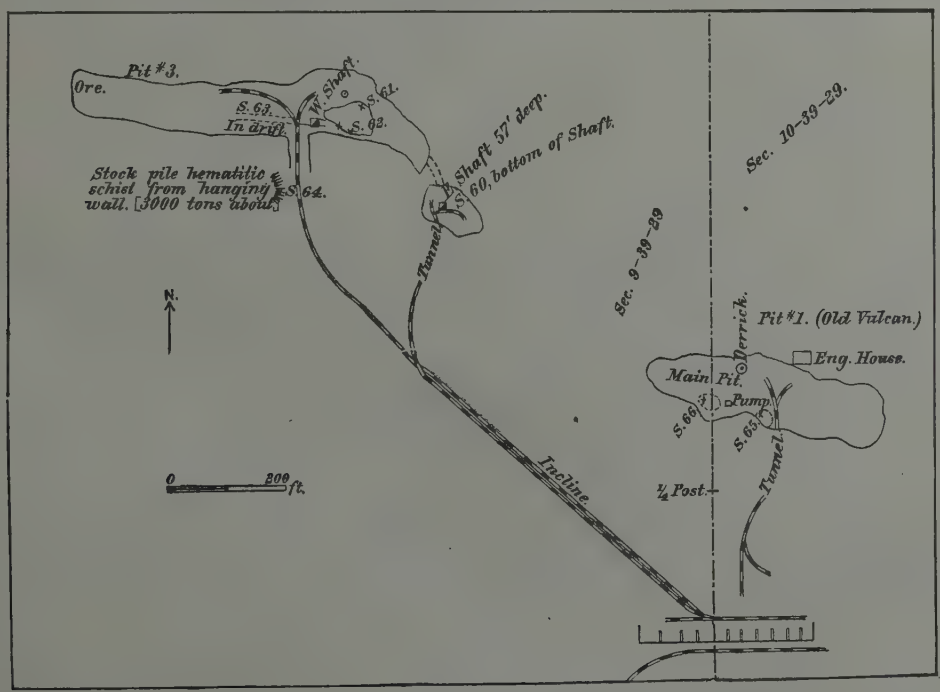


FIG. 192.—SKETCH PLAN OF THE VULCAN MINE, MENOMINEE COUNTY, MICHIGAN.

The western pit has thus far been chiefly wrought open to day, but the workings on the south side are now partly under the hanging-wall. Along the foot-wall in this pit there is a red hematitic schist, which, in places, is 3 to 4 feet thick. A little of this schist has been shipped as an iron ore; sample No. 61 was taken from about a ton

a of it in the pit. Sample No. 62 was taken from the breast of blue ore on the south side of the pit. East of the tram-road a shaft has been sunk to a depth of about 50 feet, and from it drifts have been driven in either direction. Sample No. 63 is from the end of the western drift, about 100 feet west from the shaft. As shown by the sketch, the stripping has been removed for some distance west of the shaft. No ore had been mined from this portion of the pit, however, at the date of my visit. The ore is overlaid by a ferruginous silicious schist, which, near the ore-body, sometimes contains so much iron as to constitute a lean ore. A good exposure of this schist is seen in the cut through which the tramway enters the western pit. At this point there is probably a thickness of 15 feet of the schist, containing as much iron as the pile of 3,000 tons from which sample No. 64 was taken. None of this has been shipped, but when it has been necessary to take it down, it has been kept separate from the rock.

b Sample No. 134 represents the shipping product of the mine. It was taken at Cleveland by Mr. Willis. The above-mentioned samples contained:

c

	60.	61.	62.	63.	64.	134.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	67.62	58.41	66.00	66.73	34.69	62.60
Phosphorus	0.001	0.014	0.001	0.001	0.013	0.024
Sulphur	0.050	.....	.....	.....	.....	0.075
Phosphorus in 100 parts iron	0.001	0.024	0.002	0.002	0.037	0.038
Silica	.....	.....	.....	.....	.....	4.98
Alumina	.....	.....	.....	.....	.....	2.20
Insoluble	.....	.....	.....	.....	.....	6.03

Following is the complete analysis of No. 60:

d

	60.		60.
	Per cent.		*Per cent.*
Silica	1.23	Per cent. of insoluble silicious matter	1.55
Iron, protoxide	1.19		
Iron, peroxide	95.22	Silica	1.23
Alumina	0.74	Alumina	0.21
Lime	0.21	Lime	0.02
Magnesia	0.50	Magnesia	0.01
Iron, disulphide	0.093	Potassa	0.06
Potassa	0.06		
Carbonic acid	0.19	Total	1.53
Phosphoric acid	0.003		
Titanic acid	Trace.		
Water of composition	0.55		
Total	99.986		

e (5) *Curry.*—On W. ½ of NE. ¼ Sec. 9, T. 39, R. 29. Operated by the Curry Iron Company. First shipment in 1879. Total product, 38,921 tons. Product in census year, 21,813 tons. The plan of the workings is indicated in Fig. 193. There are two pits. In the western pit the strike is a trifle north of west, and the dip is nearly vertical. The ore is from 10 to 12 feet wide, and has been worked by carrying back one stope for a distance of 150 feet. At the eastern end the pit is about 15 feet deep, and here a shaft has been sunk in preparation for another stope. About 100 feet east of this shaft the formation makes a sharp bend to the north and northwest, forming a complete bow, and returning finally to its original direction, *i. e.*, approximately east and west. The ore dips toward the center of the basin thus formed; it has been uncovered and exploited, on the north side of the bend, to a depth of 25 or 30 feet. When visited, no ore was being mined, and the bottom of the pits were covered with snow and frozen gravel. Four samples were taken, as follows:

f Sample No. 56, across the bottom of the western pit. Sample No. 57, from a mass of ore recently uncovered at the point where the vein bends sharply, and about 3 feet below grass-line. The ore is very soft, and a portion of it has an indigo tinge of color. Sample No. 58, across the bottom of the main pit. Sample No. 59, from a layer of ore about a foot thick, found near the hanging-wall (on the east side of the main pit). The ore resembles No. 65 (Vulcan mine) in weathering to a grayish color. The samples contained—

	56.	57.	58.	59.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	66.49	67.40	67.53	67.03
Phosphorus	0.062	0.010	0.008	0.005
Phosphorus in 100 parts of iron	0.093	0.015	0.012	0.007

(6.) *Saginaw Section* 4 (now called the *Perkins*).—On SW. ¼ of SW. ¼ Sec. 4, T. 39, R. 29. Operated by the Saginaw Iron Company. First shipment in 1879. Total product, 70,476 tons. Product in census year, 35,840 tons. The formation, as exposed by the present workings, has an east and west trend, and dips to the south at

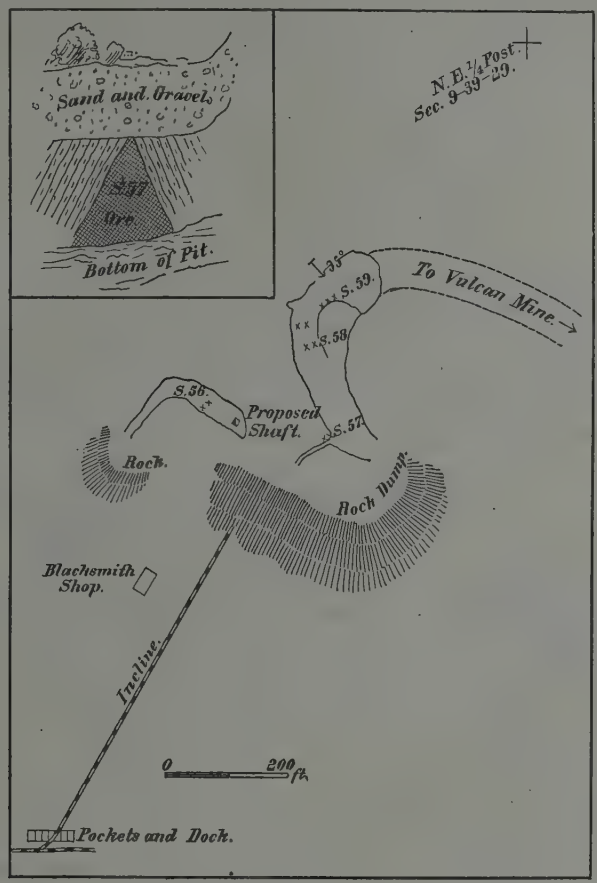


FIG. 193.—SKETCH PLAN OF THE CURRY MINE, MENOMINEE COUNTY, MICHIGAN.

an angle of about 70°. The ore-body varies in width from 10 to 25 feet. It has been uncovered for a length of several hundred feet, and into the ledge thus exposed four pits have been sunk to depths varying from 25 to 60 feet. The pits are numbered from 1 to 4, No. 1 being the easternmost. No. 4 is the deepest (see Fig. 194). The samples collected at the mine contained—

	48.	51.	49.	50.	54.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	59. 86	63. 25	59. 47	51. 71	59. 39
Phosphorus	0. 005	0. 032	0. 006	0. 008	0. 004
Phosphorus in 100 parts iron	0. 008	0. 051	0. 010	0. 015	0. 007

Sample No. 48 consists of a series of chippings taken across the west side of pit No. 1. The ore is here about 17 feet wide. Much of it has a brecciated appearance, the angular fragments being hard, specular ore (more or less silicious), and the cement a soft, reddish hematite. Sample No. 51 is from the west side of pit No. 2, near the foot-wall. A section across the ore-body at this point is shown in the figure. The ore near the foot-wall (and represented by this sample) is made up of alternating layers of hard specular and soft ore, the structure being similar to that of the jaspery schist, except that the silicious matter is replaced by iron oxide. Sample 49 is from a layer of hard, compact, specular ore (the so-called "steely-ore") from the east side of pit No. 3. This layer is 6 inches wide and lies next the hanging-wall. Layers and bunches of ore similar to this are found to some extent in all parts of the mine. The ore resembles the hard ore of the Marquette region. Sample No. 50 was taken also from the east side of pit No. 3, and consists of a series of chippings taken across the stope, exclusive of the above-mentioned

a layer of hard ore. This ore, as a whole, has a laminated or slaty structure and is quite soft. Sample No. 54 is from the east side of pit No. 4. It resembles the ore from pit No. 1 (sample No. 48), both in general appearance and in composition.

Through the ore-body there are many bunches of silicious material, which are, to a greater or less degree, sorted out in mining. In order to obtain a fair average of the shipping product of the mine samples were taken from the two stock-piles. These samples contained—

b

	52.	53.
	Per cent.	*Per cent.*
Metallic iron	57.37	56.91
Phosphorus	0.007	0.006
Phosphorus in 100 parts iron	0.012	0.010

Sample No. 52 is from 1,700 tons of ore from pits Nos. 1 and 2. Sample No. 53 is from 2,000 tons of ore from pits Nos. 3 and 4. The ore was not sampled at Cleveland.

(7) *Stephenson.*—On NW. ¼ of SW. ¼ Sec. 4, T. 39, R. 29. Operated by the Lumberman's Mining Company. First shipment in 1879. Total product, 27,036 tons. Product in census year, 14,000 tons. From the dip of the ore, which is toward the south, at an angle of about 45°, it results that the mine, as limited by the property lines,

c

d

e

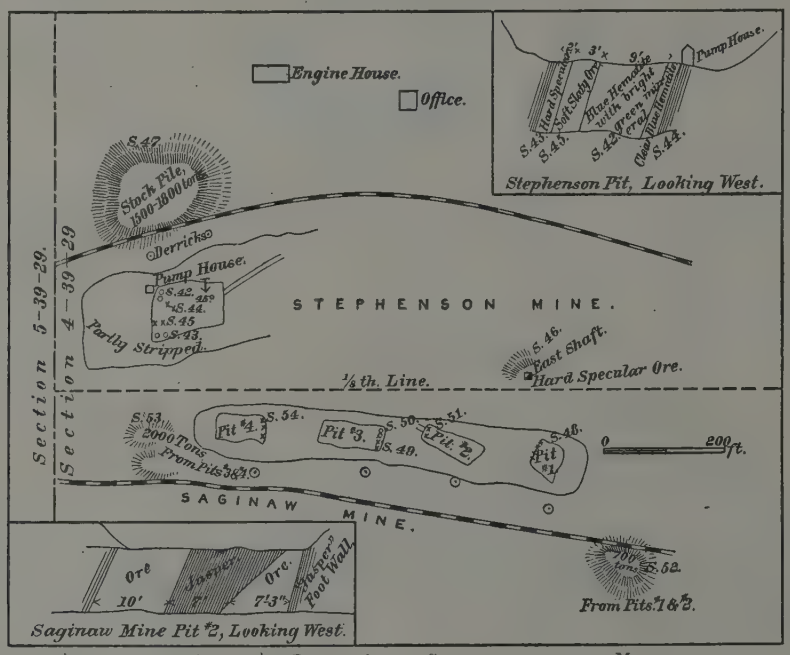


FIG. 194.—SKETCH PLANS OF THE SAGINAW (PERKINS) AND STEPHENSON MINES, MENOMINEE COUNTY, MICHIGAN.

will soon be exhausted. But the ore will doubtless be exploited at some future time by the lessees of the Saginaw mine. The one pit on the property is about 125 feet long and 75 feet wide. The stope is at the western end of the pit, where the ore is 15 feet wide. The latter width is made up of four bands of ore, as shown on the sketch f (Fig. 194). There is no rock between the walls. The samples collected at this mine contained—

	44.	42.	45.	43.	47.	46.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	52.59	56.47	61.48	63.53	58.20	52.78
Phosphorus	0.086	0.094	0.048	0.068	0.081	0.069
Sulphur	.....	.....	.....	.....	.....	0.004
Phosphorus in 100 parts iron	0.163	0.166	0.078	0.107	0.139	0.131

Following is the complete analysis of No. 46:

	46.		46.
	Per cent.		*Per cent.*
Silica	13.85	Hygroscopic water	0.04
Iron, protoxide	2.97	Water of composition	2.75
Iron, peroxide	72.06	Total	100.055
Alumina	3.39		
Manganese, protoxide	0.11	Per cent. of insoluble silicious matter	14.26
Lime	0.33	Silica	13.85
Magnesia	4.29	Alumina	0.44
Iron, disulphide	0.007	Total	14.29
Carbonic acid	0.10		
Phosphoric acid	0.158		

Samples Nos. 42 to 45, inclusive, are from the stope in the main pit. Beginning at the foot-wall, sample No. 44 represents a layer, 1 foot thick, of a clean blue ore which turns to a grayish color on exposure. Sample No. 42 a compact blue ore, containing a large admixture of a greenish magnesian mineral, the color of which is very bright and striking, especially when the ore is wet. The width of the band is 9 feet. The ore is mediumly soft. Sample No. 45, a soft, blue, slaty ore, 3 feet thick, which lies next the 9-foot band, and sample No. 43, a hard specular ore 2 feet thick, which lies next the hanging-wall. The location of these samples is marked on the sketch.

Sample No. 47 represents an average of a pile of about 1,800 tons of the ore mined from this pit, and indicates the composition of the shipping product. The ore was not sampled at Cleveland.

Sample No. 46 was collected from a pile of about 75 tons of ore, which had been thrown out from a test-shaft sunk near the property line, about 100 feet north of pit No. 1 of the Saginaw mine. The shaft is reported to be 75 feet deep; it was filled with water. The ore is a hard specular.

(8) *Norway.*—On NE. ¼ of SE. ¼ Sec. 5, T. 39, R. 29. Operated by the Menominee Mining Company. First shipment in 1878. Total product, 312,803 tons. Product in census year, including product of the Cyclops mine, 210,874 tons. The trend of the formation is about N. 60° W.; the dip is southward. The openings extend for a distance of about a quarter of a mile, but are chiefly shallow, open pits.

The general plan of the workings and location of the samples is shown on Fig. 195. The pits are numbered from 1 to 10, the latter being at the northwestern end of the workings, near the top of the ridge.

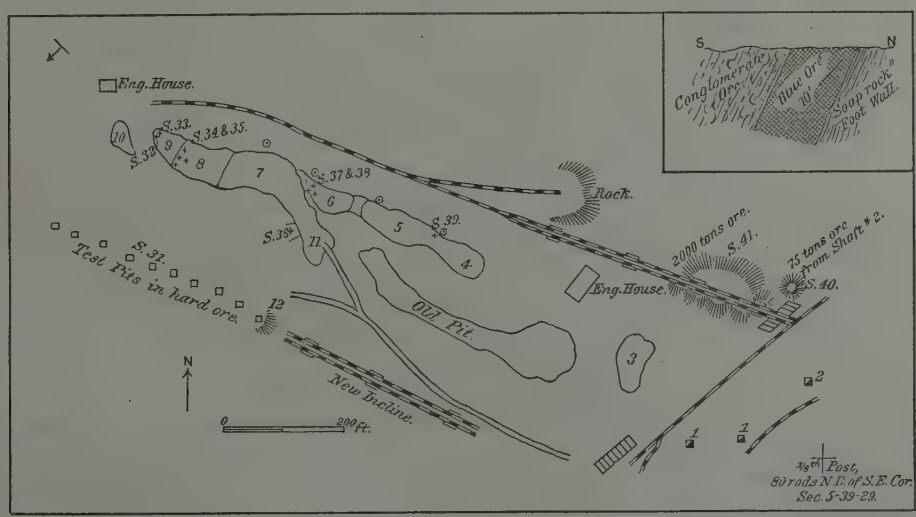


Fig. 195.—Sketch plan of the Norway mine, Menominee county, Michigan.

Pit No. 10 is about 100 feet south of the new engine-house. It is a new opening and was not being worked at the date of my visit to the mine.

Pit No. 9 is 15 feet deep. The stope is on the east side of the pit and presents two varieties of ore—the one having a slaty and the other a brecciated structure. The latter is composed of irregular angular pieces of hard specular ore cemented together with soft brown hematite. The blue slaty ore lies next the foot-wall and is about 10 feet thick. The thickness of the brecciated ore is undetermined, as the hanging-wall has not been reached. Sample No. 32 represents the brecciated ore, and sample No. 33 the blue slaty ore.

a Pit No. 8.—The ore in this pit is essentially a soft, reddish-brown hematite containing pieces and bunches of various sizes, of hard specular ore. Selected chippings of these two varieties of ore were collected in the pit. Sample No. 34 represents the soft ore and sample No. 35 the hard ore.

The above-mentioned samples are compared in the following analyses:

b

	32.	33.	34.	35.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	49.56	59.72	52.97	58.35
Phosphorus	0.035	0.030	0.045	0.014
Phosphorus in 100 parts iron	0.071	0.050	0.085	0.024

In the eastern part of pit No. 7 a width of 150 feet or more of ore has been uncovered without exposing the hanging-wall rock. The foot-wall, on the north side of the pit, dips, however, at a flat angle (25° to 30°), so that the horizontal width is necessarily much greater than the normal width of the deposit. The southern portion of this pit is known as No. 11. The ore in pit No. 7 proper resembles that in pit No. 8. Sample No. 36 was taken across the stope.

c In pit No. 11 a large proportion of the ore is the hard specular variety. A sample (No. 55) of the shipping product of this pit, in which the hard ore formed about two-thirds of the whole, was taken from loaded cars.

In pit No. 6 two samples were taken. Sample No. 38 is from a pile of broken ore, and represents the average output of the pit.

Sample No. 37 consists of selected chippings of an ore which contains a yellowish-green mineral, and which, although found in several of the pits, is here concentrated in a well-defined band along the south side of the pit. The above-mentioned samples contained—

d

	36.	55.	38.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	59.26	57.39	62.08
Phosphorus	0.019	0.41	0.064
Phosphorus in 100 parts iron	0.032	0.071	0.103

e

	37.		37.
	Per cent.		*Per cent.*
Metallic iron	62.73	Carbon in carbonaceous matter	0.006
Phosphorous	0.084	Hygroscopic water	0.27
Sulphur	0.058	Water of composition	1.21
Phosphorus in 100 parts iron	0.134	Total	100.207
Silica	3.42	Per cent. of insoluble silicious matter	3.70
Iron, protoxide	0.82		
Iron, peroxide	88.77	Silica	3.42
Alumina	2.37	Alumina (with trace of oxide of iron)	0.12
Lime	1.10	Lime	0.26
Magnesia	1.44	Magnesia	0.02
Iron, disulphide	0.109	Total	3.82
Carbonic acid	0.50		
Phosphoric acid	0.192		

In pit No. 4, sample No. 39 was taken across the stope, which latter is 16 feet wide. The ore resembles closely that from pit No. 6 (sample No. 38).

f South and southwest from pits Nos. 4 and 5 is a long trench, from which the ore has been all exploited. East of this latter is pit No. 3, an oval excavation 100 feet long, 75 feet wide, and 70 feet deep. The sides are irregular, but nearly vertical. Only exploratory work was being done here in December, 1879.

West of pit No. 3 shafts have been sunk on what are supposed to be the extensions of the Saginaw Section 4 (Perkins) and the Stephenson veins. Shaft No. 2, called the Stephenson shaft, is about 75 feet deep. The ore takes a grayish tinge of color on exposure, and in this respect differs greatly from the ore from the open pits, which soon becomes red on handling. Sample No. 40 is from a pile of 75 tons of ore from shaft No. 2.

Returning to the top of the ridge, a line of test-pits has been sunk about 80 paces south of pits Nos. 7, 8, and 9, and nearly on a line with the new incline. The majority of these pits are bottomed in a hard specular ore, which on fresh fracture resembles that in pit No. 1. Sample No. 31 was collected from the numerous pieces thrown out from these pits.

Sample No. 41 is from a stock-pile of about 2,000 tons of ore from pits Nos. 4, 5, 6, 7, and 9, and sample No. a
135 is from a stock-pile of 6,000 tons of ore at Cleveland. The latter was collected by Mr. Willis. The above-mentioned samples contained—

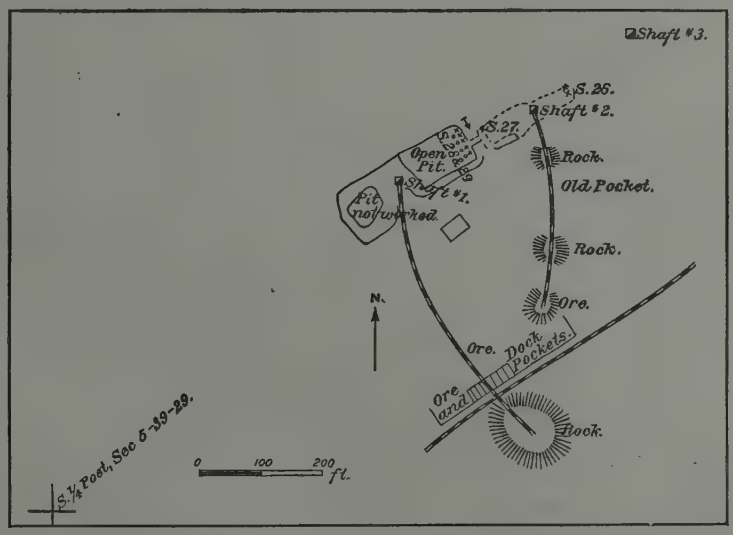
	39.	40.	31.	41.	135.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	61.94	51.09	60.20	56.12	55.49
Phosphorus	0.108	.....	0.047	0.068	0.057
Sulphur	.....	0.058	0.043	.....	0.071
Phosphorus in 100 parts iron	0.174	.....	0.078	0.121	0.103

b

	31.	40.	135.
	Per cent.	*Per cent.*	*Per cent.*
Silica	12.43	11.88	16.03
Iron, protoxide	0.68	3.77	.....
Iron, peroxide	85.19	68.74	.....
Alumina	0.02	5.49	1.73
Manganese, protoxide	.....	0.03	} Present.
Manganese, dioxide	.....	.....	
Lime	0.68	0.93	.....
Magnesia	0.21	5.55	.....
Iron, disulphide	0.080	0.109	.....
Carbonic acid	0.40	0.13	.....
Phosphoric acid	0.108	.....	.....
Titanic acid	.....	.....	Absent.
Carbon in carbonaceous matter	0.006	.....	.....

	31.	40.	135.
	Per cent.	*Per cent.*	*Per cent.*
Hygroscopic water	.....	.....	0.09
Water of composition	0.284	3.52	.....
Total	100.088	100.239	.....
Per cent. of insoluble silicious matter	12.78	12.39	16.86
Silica	12.43	11.88	 c
Alumina (with trace of oxide of iron)	0.26	0.31	.....
Lime	0.07	0.19	.....
Magnesia	0.03	0.04	.....
Total	12.79	12.42	.....

(9) *Cyclops.*—One SW. ¼ of SE. ¼ Sec. 5, T. 39, R. 29. Operated by the Menominee Mining Company. First shipment in 1878. Total product, 75,169 tons. Product in census year included with product of Norway mine. Fig. 196 indicates the general plan of the mine. Shaft No. 1 is 100 feet deep, and the ore has been mined out on either side to a depth of about 60 feet. West of the shaft the pit has been abandoned, as the ore was there too much mixed with rock to be profitably mined. East of the shaft the ore is of good quality. The stope is about d
90 feet distant, and is 30 feet wide. The ore dips southward at about 60°, and is capped by horizontal (Potsdam)



e

f

FIG. 196.—SKETCH PLAN OF THE CYCLOPS MINE, MENOMINEE COUNTY, MICHIGAN.

sandstone. Near the foot-wall the ore has a more slaty structure than elsewhere, and contains a good deal of the yellowish-green mineral noticed as occurring at the Norway mine. Sample No. 29 was taken from the hanging wall to within about 10 feet of the foot-wall, so as to avoid as far as possible the ore containing this substance. Sample No. 30 was taken entirely across the stope.

Shaft No. 2, 200 feet northeast of No. 1, is 75 feet deep, and passes through 30 feet of sandstone, which latter forms the roof of the mine. Sample No. 27 is from a band of ore in the west stope near the foot-wall, similar to that seen in pit No. 2. This sample, therefore, supplements No. 29. The lens of good ore pinches out at a point about 75 feet east of shaft No. 2.

a Sample No. 28 was taken from the lean ore in the stope, principally for the determination of phosphorus Sample No. 117 was taken at Cleveland by Mr. Willis from a pile of 1,000 tons, and represents the shipping product of the mine. The above-mentioned samples contained—

	29.	30.	27.	28.	117.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	65.90	64.38	53.58	29.58	62.05
Phosphorus	0.012	0.013	0.013	0.012	0.013
Sulphur					0.066
Phosphorus in 100 parts iron	0.018	0.020	0.024	0.041	0.021

b

	117.
	Per cent.
Silica	5.61
Alumina	2.50
Manganese	Absent.
Titanic acid	Absent.
Per cent. of insoluble silicious matter	6.31

c

(10) *Quinnesec.*—On SE. ¼ of Sec. 34, T. 40, R. 30. Operated by the Menominee Mining Company. First shipment in 1878. Total product, 135,465 tons. Product in census year, 63,688 tons. The workings are entirely

d

e

f

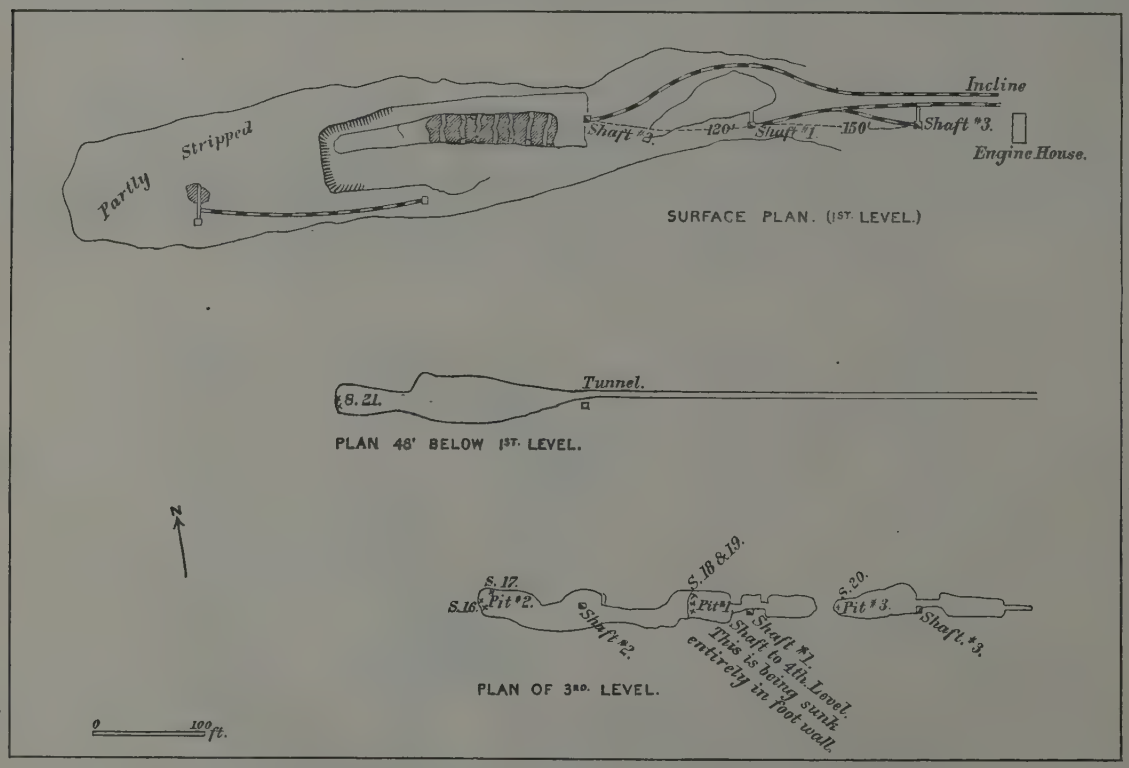


FIG. 197.—SKETCH-PLANS OF THE QUINNESEC MINE, MENOMINEC COUNTY, MICHIGAN.

underground, and are entered by three shafts sunk on the ore, which dips northward at an angle of 70° (see Fig. 197). The present surface around the shafts is the bottom of the original open cut, and is known as the first level. The second or adit level is 48 feet below the first level, and the third level is 112 feet below the same datum. All the ore above the adit, with the exception of a little at the extreme western end of the mine, has been removed, and the main workings are on the third level. In pit No. 2, at the western end of this level, and 95 feet west of shaft No. 2, the stope is 28 feet wide. The ore is a blue specular, usually quite soft, but varying somewhat in hardness in different portions of the stope. Near the hanging-wall there is a band of ore 10 inches wide, which contains thin layers of a greenish magnesian mineral of the same character as that found in the Norway and Cyclops mines. Its

peculiar color readily distinguishes it, and judging from the analyses of sample No. 17, which consists of selected a chippings taken in this stope, it is chemically a silicate of alumina and magnesia. Sample No. 11 was taken entirely across the stope in this same room. In pit No 1, west of shaft No. 1, the ore is 32 feet wide. It is similar to that in pit No. 2, excepting that the proportion of hard ore is, perhaps, greater. This latter occurs in pockets and in narrow layers; it is as a rule much softer than the specular ore of the Norway mine. Sample No. 18 consists of a series of chippings across the stope, and sample No. 19 of selected pieces of the hard ore.

The above-mentioned samples were subjected to complete analysis, with the following results:

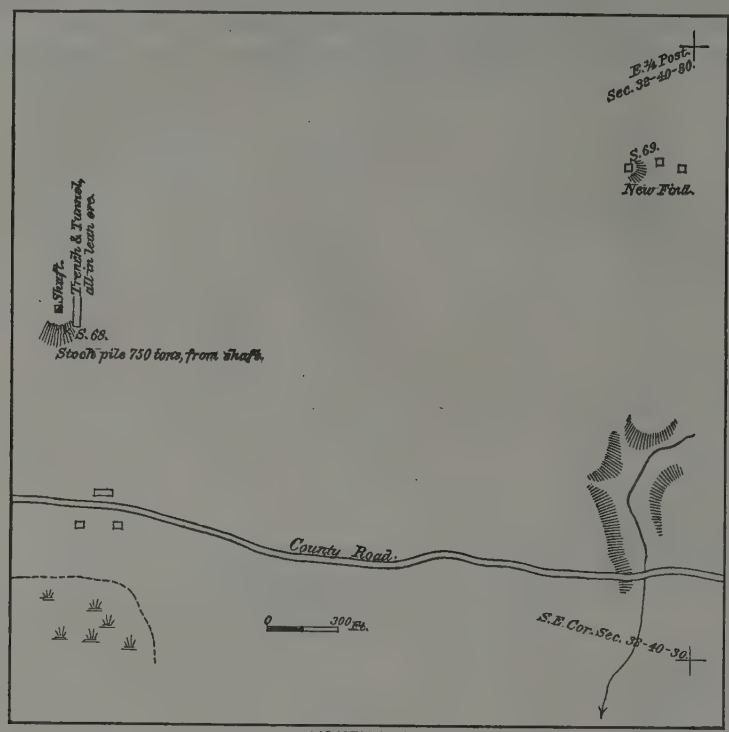
	16.	17.	18.	19.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	
Sulphur	0.050	0.059	0.086	0.050	b
Phosphorus	0.010	0.009	0.012	0.005	
Iron, metallic	61.81	55.49	66.39	64.47	
Phosphorus in 100 parts iron	0.016	0.016	0.018	0.008	
Silica	7.37	9.29	2.58	6.99	
Iron, protoxide	1.97	2.87	1.81	2.36	
Iron, peroxide	86.05	76.02	92.73	89.41	
Alumina	1.81	4.68	0.86	0.35	
Manganese, protoxide	.....	.....	Trace.	Trace.	
Lime	0.41	0.27	0.50	0.29	
Magnesia	0.84	3.54	0.31	0.13	c
Iron, disulphide	0.090	0.110	0.161	0.093	
Potassa	0.55	0.99	0.37	0.05	
Soda	.....	0.02	.....	0.03	
Carbonic acid	0.19	0.30	0.38	0.24	
Phosphoric acid	0.024	0.021	0.027	0.013	
Hygroscopic water	0.20	0.16	0.01	.....	
Water of composition	0.50	1.72	0.30	0.01	
Total	100.004	99.991	100.038	99.966	
Per cent. of insoluble silicious matter	8.94	12.00	3.65	7.40	
Silica	7.37	9.29	2.58	6.99	d
Alumina	0.93	1.61	0.70	0.25	
Lime	0.14	0.09	0.01	0.02	
Magnesia	0.05	0.09	0.12	0.05	
Potassa	0.46	0.93	0.30	0.05	
Soda	.....	.....	.....	0.03	
Total	8.95	12.01	3.71	7.39	

Pit No. 3, west of shaft No. 3, is about 20 feet wide. Sample No. 20 was taken across the vein at the end of the drift over the stope. The eastern limit of the lens of ore is reached in a drift at a point about 100 feet east of shaft No. 1; the lens apparently has a westerly pitch. On the second or adit level a sample (No. 21) was taken e near the foot-wall of the pocket of ore there being mined. The ore is quite hard and has a laminated or slaty structure, the laminæ being often highly contorted; it is called "curly" ore by the miners. Sample 119 shows the character of the shipping product of the mine; it was taken from a pile of 4,000 tons of the ore at Cleveland by Mr. Willis. The above-mentioned samples contained—

	No. 20.	No. 21.	No. 119.		No. 20.	No. 21.	No. 119.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	65.60	64.38	63.49	Phosphoric acid	0.021	.....	.....
Phosphorus	0.009	0.008	0.038	Hygroscopic water	0.04	.....	.....
Sulphur	0.053	.....	0.008	Water of composition	0.27	.....	..... f
Phosphorus in 100 parts iron	0.014	0.012	0.060	Total	99.980	.....	.....
Silica	3.03	.....	5.52	Per cent. of insoluble silicious matter	4.61	.....	7.00
Iron, protoxide	1.97	.....	.....				
Iron, peroxide	91.47	.....	.....	Silica	3.03	.....	.....
Alumina	1.53	.....	1.87	Alumina	0.93	.....	.....
Manganese, protoxide	.....	.....	Trace.	Lime	0.07	.....	.....
Lime	0.36	.....	.....	Magnesia	0.06	.....	.....
Magnesia	0.21	.....	.....	Potassa	0.51	.....	.....
Iron, disulphide	0.099	.....	.....	Soda	0.03	.....	.....
Potassa	0.57	.....	.....	Total	4.63	.....	.....
Soda	0.06	.....	.....				
Carbonic acid	0.38	.....	.....				

The Quinnesec completes the list of the mines in the Menominee range which shipped ore previous to the year 1880. The samples that follow were taken from outcrops and exploration pits, and probably do not, therefore, represent a fair average of the shipping product of the since-developed mines.

Keel Ridge mine (now so-called).—On NW. ¼ of SE. ¼ of Sec. 32, T. 40, R. 30. Operated by the Emmet Mining Company. Product in 1880, 12,818 tons. At the date of my visit the developments consisted of two shafts (then filled with water), and a short tunnel cross-cutting the strata (see Fig. 198). A sample (No. 68) was taken from



McKENNA MINE.

FIG. 198.—SKETCH-PLAN OF THE KEEL RIDGE MINE, MENOMINEE COUNTY, MICHIGAN.

about 750 tons of ore from the shafts. On the NE. ¼ of SE. ¼ of the same section three or four test-pits have been sunk through the sandstone and are bottomed in ore. The ore is a blue, specular hematite, but in the small pile from which sample No 69 was taken a considerable amount of silicious material was mixed through it. Samples Nos. 68 and 69 contained—

	68.	69.
	Per cent	*Per cent.*
Metallic iron	54.39	50.00
Phosphorus	0.061	0.005
Phosphorus in 100 parts iron	0.112	0.010
Silica	3.94	.....
Iron, protoxide	1.36	.....
Iron, peroxide	76.18	.....
Alumina	1.18	.....
Manganese, protoxide	0.17	.....
Lime	4.87	.....
Magnesia	3.60	.....
Carbonic acid	7.12	.....
Phosphoric acid	0.139	.....
Hygroscopic water	0.23	.....
Water of composition	1.29	.....
Total	100.079	.....
Per cent. of insoluble silicious matter	4.08	.....
Silica	3.94	.....
Alumina	0.17	.....
Total	4.11	.....

Chapin.—On SW. ¼ of SE. ¼ of Sec. 30, T. 40, R. 30. Operated by the Menominee Mining Company. Product in 1880, 38,703 tons; product in census year, 7,878 tons. In December, 1879, the developments here consisted of a row of exploration shafts (see Fig. 199). Shaft No. 1 is 300 paces east of the south quarter-post of the section

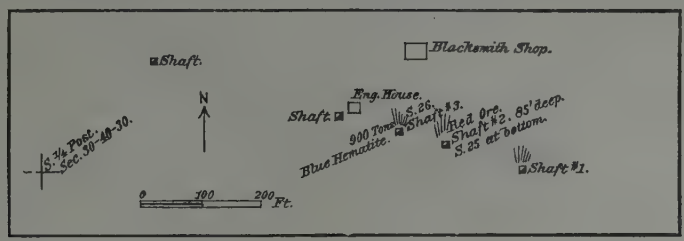


FIG. 199.—SKETCH-PLAN OF THE CHAPIN MINE, MENOMINEE COUNTY, MICHIGAN.

and 5 paces north of the south line. It is about 65 feet deep, and, according to the superintendent of the mine, passes through (1st) 40 feet of earth and gravel, (2d) 4 feet of a coarsely-granular ore, (3d) 20 feet of "soap-rock" (probably a chloritic schist) before entering (4th) the blue ore in which it is bottomed. Sample No. 26A is from a few tons of the coarsely-granular ore thrown out from this shaft. Shaft No. 2 is 120 feet west of No. 1, and is 85 feet deep. It passes through 50 feet of surface material before reaching the ore; the latter is in part a soft, blue specular, and in part a reddish-brown, ore. The brown ore appears to be about 4 feet thick, and to lie in contact with the foot-wall rock, which dips at 70° to the northward. Shaft No. 3, 220 feet west of No. 2, is 125 feet deep. The ore is all of a blue color and is covered with 60 feet of gravel. Shafts Nos. 4 and 5 are, respectively, 320 and 570 feet west of No. 1, and are both bottomed in ore. Sample No. 25 represents the brown ore from the bottom of shaft No. 2; the sample was taken from the wall of the shaft. Sample No. 26 is from a pile of about 900 tons of ore from shaft No. 3. The samples yielded, on analysis—

	26A.	25.	26.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	50.43	62.65	65.97
Phosphorus	0.014	0.011	0.007
Sulphur	.....	0.018	0.001
Phosphorus in 100 parts iron	0.028	0.018	0.011
Silica	.....	4.42	3.23
Iron, protoxide	.....	1.81	0.81
Iron, peroxide	.....	87.47	93.34
Alumina	.....	2.37	1.03
Manganese, protoxide	.....	0.25	0.03
Lime	.....	0.26	0.06
Magnesia	.....	1.58	0.45
Iron, disulphide	.....	0.034	0.002
Potassa	.....	0.38	0.53
Carbonic acid	.....	0.12	0.11
Phosphoric acid	.....	0.026	0.017
Carbon in carbonaceous matter	.....	0.01	.....
Hygroscopic water	.....	0.19	0.07
Water of composition	.....	1.12	0.39
Total	.....	100.040	100.069
Per cent. of insoluble silicious matter	.....	5.28	4.82
Silica	.....	4.42	3.23
Alumina	.....	0.64	1.06
Lime	.....	0.01	0.02
Magnesia	.....	0.03	0.05
Potassa	.....	0.20	0.50
Total	.....	5.30	4.86

Ludington.—On N. ½ of SE. ¼ of Sec. 25, T. 40, R. 31. Operated by the Lumbermen's Mining Company. Product in 1880, 9,941 tons; product in census year, 2,800 tons. When visited the opening consisted of a trench, about 100 feet long, and a shaft. The body of ore exposed in the trench is 10 feet wide at one point, but it narrows in either direction. The trench, which is carried the full width of the ore, is but 2 feet wide at the ends. The shaft

a is bottomed in ore, but not sufficient work has been done to determine the latter's extent. About 150 tons of ore has been taken from the trench and is piled at the mine; it is a soft, blue specular of excellent quality, as is shown by the following analysis of an average sample of the pile:

	24.
	Per cent.
Metallic iron	62.23
Phosphorus	0.008
Phosphorus in 100 parts iron	0.013

b

c

d

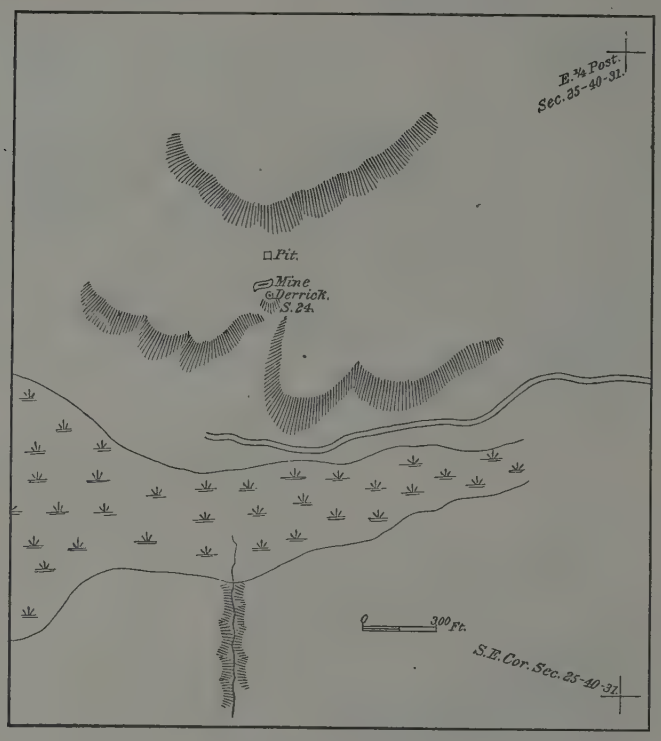


FIG. 200.—SKETCH-PLAN OF THE LUDINGTON MINE, MENOMINEE COUNTY, MICHIGAN.

e *Cornell.*—On the north side of lake Antoine, 1 mile S. of N. ¼ post, Sec. 20, T. 40, R. 30. Operated by R. A. Wight and A. B. Cornell. Product in 1880, 34,559 tons: product in census year, 7,840 tons. When visited the

f

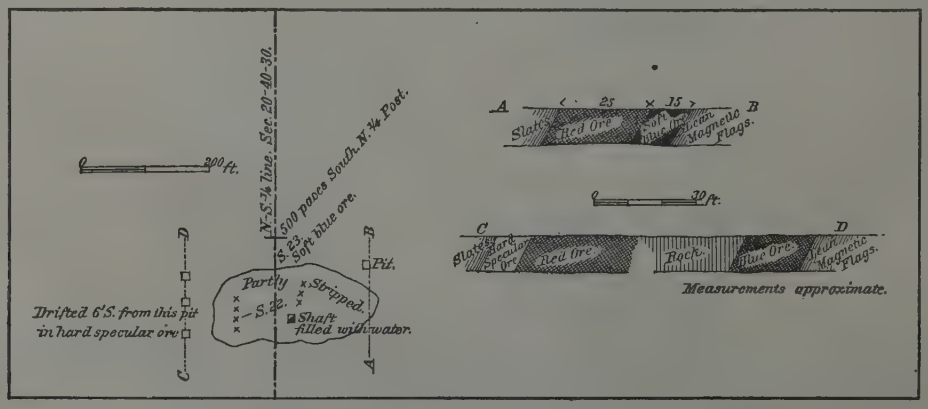


FIG. 201.—SKETCHES OF THE CORNELL MINE, MENOMINEE COUNTY, MICHIGAN.

outlook for the mine appeared very promising; the removal of the surface material had exposed a body of ore 60 feet long and at one point 40 feet wide. The trend of the formation is nearly east and west, and the dip is to

the south at an angle of 70° to 75°. On the north the ore is bounded by a lean magnetic schist; lying next this schist is a band of soft, blue specular ore 15 feet wide, and south of this a band of "red" ore 25 feet in width (see Fig. 201). Sample No. 22 represents the red ore and sample No. 23 the blue ore. These samples contained— a

	22.	23.		22.	23.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	58.06	56.99	Phosphoric acid	0.097	0.074
Phosphorus	0.043	0.032	Hygroscopic water	0.11	0.07
Sulphur	0.059	0.078	Water of composition	1.13	0.56
Phosphorus in 100 parts iron	0.074	0.056	Total	99.988	99.950
Silica	9.04	10.71	Per cent. of insoluble silicious matter	13.61	16.44
Iron, protoxide	1.10	1.10			
Iron, peroxide	81.64	80.09	Silica	9.04	10.71
Alumina	3.83	3.88	Alumina	2.77	3.21
Lime	0.19	0.17	Lime	0.01	.....
Magnesia	0.86	0.48	Magnesia	0.26	0.08
Iron, disulphide	0.111	0.146	Potassa	1.44	2.23
Potassa	1.54	2.29	Soda	0.11	0.20
Soda	0.17	0.30			
Carbonic acid	0.18	0.08	Total	13.63	16.43

b

c

WISCONSIN.

Explorations west of the Menominee river in Wisconsin have resulted in the discovery of important deposits of iron ore in T. 40, R. 18. These ores belong to a higher horizon than do those east of the river. Major Brooks places them in bed XV;(*a*) he therefore regards them as younger than the ores of the Marquette region. Wright, (*b*) however, considers them as stratigraphically the equivalent of the rich ores of the Marquette region. The ores of the Menominee region in Michigan (of bed VI) have thus far not been traced in Wisconsin.

Commonwealth mine.—The explorations made near the center of Sec. 34, T. 40, R. 18 have uncovered a total width of 118 feet of ore lying in three belts, respectively, 36, 68, and 14 feet wide. The two larger belts are separated by 10 feet of lean ore, and 28 feet of silicious schist lies between the narrowest and the widest ore-belts. The extent of the developments in the fall of 1879 are fully described by Mr. Wright in Vol. III of the *Geology of Wisconsin*, and when the location was visited by the writer, in December of the same year, no further work had been done, and the old excavations were filled with ice and snow. Two samples of the ore were taken. Sample No. 72 is from a pile of about 700 tons of ore, partly from a shaft in the 36-foot seam and partly from a trench across the 68-foot seam. Sample No. 73 is from the sides of the shaft in the 14-foot seam. The samples contained— d

	72.	73.
Metallic iron	60.25	57.84
Phosphorus	0.205	0.239
Phosphorus in 100 parts iron	0.340	0.412

e

To further show the character of the ore, a complete analysis was made of a mixture of the above mentioned samples, with results as follows:

	72 and 73.		72 and 73.
	Per cent.		*Per cent.*
Metallic iron	59.36	Phosphoric acid	0.512
Phosphorus	0.224	Hygroscopic water	0.21
Phosphorus in 100 parts iron	3.77	Water of composition	1.95
Silica	7.81	Total	100.062
Iron, protoxide	0.99	Per cent of insoluble silicious matter	8.05
Iron, peroxide	83.69		
Alumina	1.97	Silica	7.81
Manganese, protoxide	0.32	Alumina	0.21
Lime	0.86	Lime	0.05
Magnesia	1.34		
Carbonic acid	0.41	Total	8.07

f

a Geology of Wisconsin, Vol. III, table facing p. 450. *b Geology of Wisconsin*, Vol. III, p. 679.

a The ore is a hard specular, resembling the hard Marquette ores. The mine is now operated by the Commonwealth Iron Company. The first shipment of ore was made in October, 1880.

About 2½ miles west of the Commonwealth mine proper the Commonwealth Iron Company have made some explorations on SW. ¼ of SW. ¼ Sec. 32, T. 40, R. 18, sinking a shaft to a depth of 65 feet, and numerous test-pits to a less depth (see Fig. 202).

b

c

d

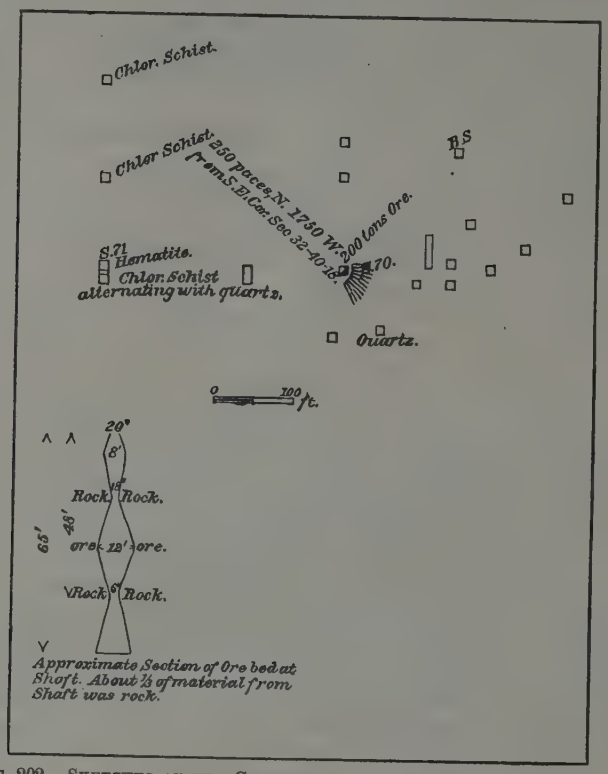


FIG. 202.—SKETCHES AT THE COMMONWEALTH MINE, SEC. 32, WISCONSIN.

The ore from the shaft is a coarsely granular martite; its character is shown by the analysis of sample No. 70, taken from a pile of about 200 tons. The body of ore is said to be very variable in width, as is indicated by the section through the shaft. The shaft was filled with water when the locality was visited. The section is given on e the authority of the foreman under whose direction the shaft was sunk. About 300 feet west of the shaft a bed of reddish-brown hematite 4 feet thick is uncovered in a trench. The ore is represented by sample No. 71. Samples Nos. 70 and 71 contained—

f

	70.	71.		70.	71.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Metallic iron	59.61	46.21	Phosphoric acid	0.396	.....
Phosphorus	0.172	0.041	Carbon in carbonaceous matter	0.12	.....
Sulphur	0.370	.....	Hygroscopic water	0.05	.....
Phosphorus in 100 parts iron	0.288	0.088	Water of composition	2.90	.....
Silica	5.71	.....	Total	100.070	.....
Iron, protoxide	7.51	.....			
Iron, peroxide	76.36	.....	Per cent of insoluble silicious matter	6.28	.....
Alumina	4.22	.....			
Maganese, protoxide	0.11	.....	Silica	5.71	.....
Lime	0.46	.....	Alumina (with trace of oxide of iron)	0.50	.....
Magnesia	1.38	.....	Lime	0.04	.....
Iron, disulphide	0.694	.....	Magnesia	0.01	.....
Carbonic acid	0.16	.....	Total	6.26	.....

Florence (formerly known as the *Eagle*) *mine.*—The explorations and discoveries in N. ½ of SE. ¼ Sec. 20, T. 40, R. 18 are described by Mr. Wright on page 682 of *Geology of Wisconsin*, Vol. III. Mr. Wright there gives a section across the ore formation as uncovered in an open trench dug on a north and south line. This section shows,

beginning at the south end of the trench, (1st) chloritic rock, 10 feet; (2d) steely specular ore, 10 feet; (3d) lean ore, a jasper, and chloritic rock, 16 feet; (4th) loose, broken, hard, hematitic ore, 15 feet; (5th) soft hematite and limonite, 18 feet; (6th) soft hematite ore, 9 feet; (7th) hard hematite and brown ore, 9 feet; (8th) hard, steely, specular ore, 6 feet. Samples from the different bands of ore yielded Mr. Wright as follows: (2d) Metallic iron, 49 per cent., phosphorus, 0.14 per cent.; (4th) metallic iron, 53.03 per cent.; (5th) metallic iron, 57 per cent., phosphorus, 0.40 per cent.; (6th) metallic iron, 58.10 per cent.; (7th) metallic iron, 58.10 per cent., phosphorus, 0.39 per cent.

No further work had been done at this locality when visited in December, 1879, and the trench from which Mr. Wright obtained his section was filled up. There was, however, a pile of ore near the test-pit, immediately east of the north end of the trench, and from this a sample (No. 74) was taken. It contained— b

	74.
	Per cent.
Metallic iron	54.91
Phosphorus	0.369
Phosphorus in 100 parts iron	0.672

During the year 1880, the Menominee Mining Company opened the Florence mine and shipped therefrom 15,840 tons of ore before the close of navigation.

Northwest of the above-mentioned exploration pits there were several test-pits in the NE. ¼ of the section. A sample from a few lumps of ore near the top of one of these yielded, on partial analysis— c

	75.
	Per cent.
Metallic iron	59.17
Phosphorus	0.285
Phosphorus in 100 parts iron	0.482

This ore is a hard specular, spotted with limonite and hematite.

REPORT OF A TRIP ON THE UPPER MISSISSIPPI AND TO VERMILION LAKE, MINNESOTA.

By Bailey Willis.

Professor Raphael Pumpelly,
Chief of Division.

Sir: On the 25th of August, 1880, I received your instructions to sample and report upon the iron ores of Minnesota.

Owing to unavoidable delays, I did not enter upon the work until September 10, when I visited the deposit north of Agate bay, on the north shore of Lake Superior.

On the 15th I left Duluth for the Upper Mississippi with Mr. George A. Fay, of Marquette, and a half-breed.

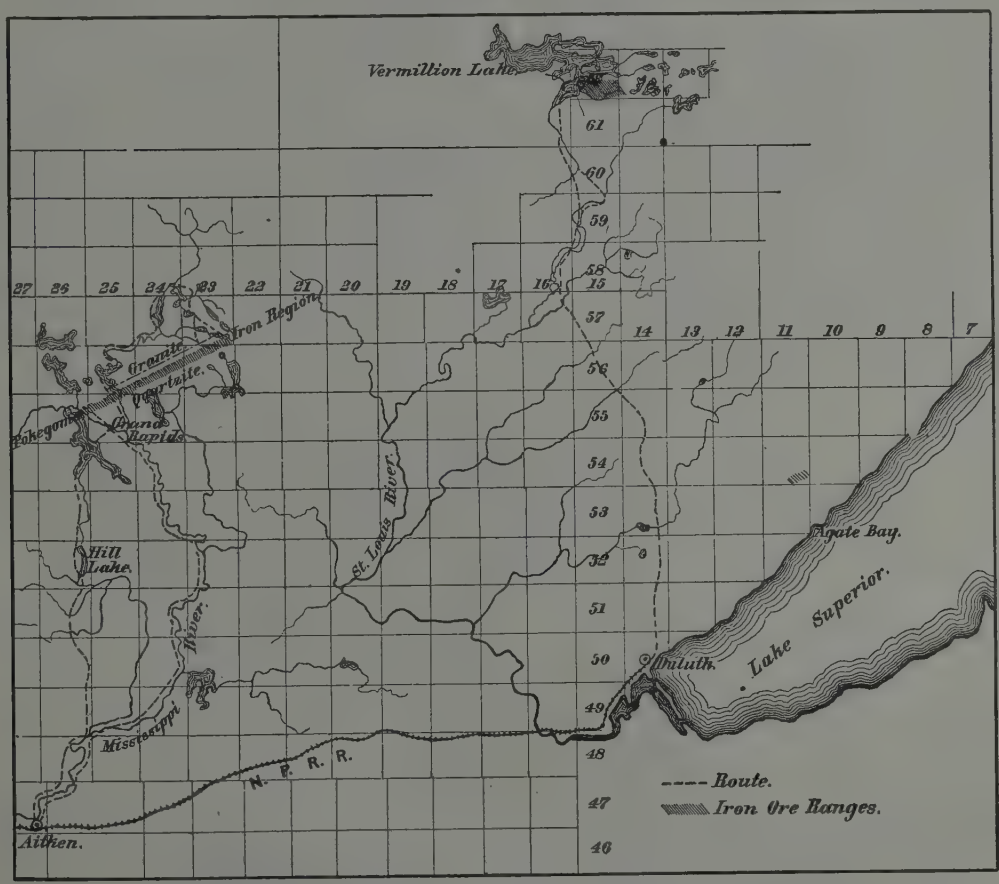


Fig. 203.—Map of a part of Northern Minnesota, showing route traversed.

Mr. Fay's illness obliged me, on the third day, to proceed without him. I was gone two weeks up the Mississippi and Prairie rivers with two Indians, and returned to Duluth on October 1. On the 3d I left Duluth with Mr. Fay and three packers for Vermilion lake. At Esquagama bridge, 65 miles from Duluth, we joined a guide, who had previously been sent up the Saint Louis river with our canoe and provisions. On the 10th we reached the Two

a Rivers range at Vermilion lake. Snow fell to the depth of 3 feet between the 15th and 17th, after which all work was done on snowshoes, during very unfavorable weather. We broke camp on the Vermilion range on November 10, and reached Duluth on the 18th.

Very respectfully, yours,

BAILEY WILLIS,
Special Agent.

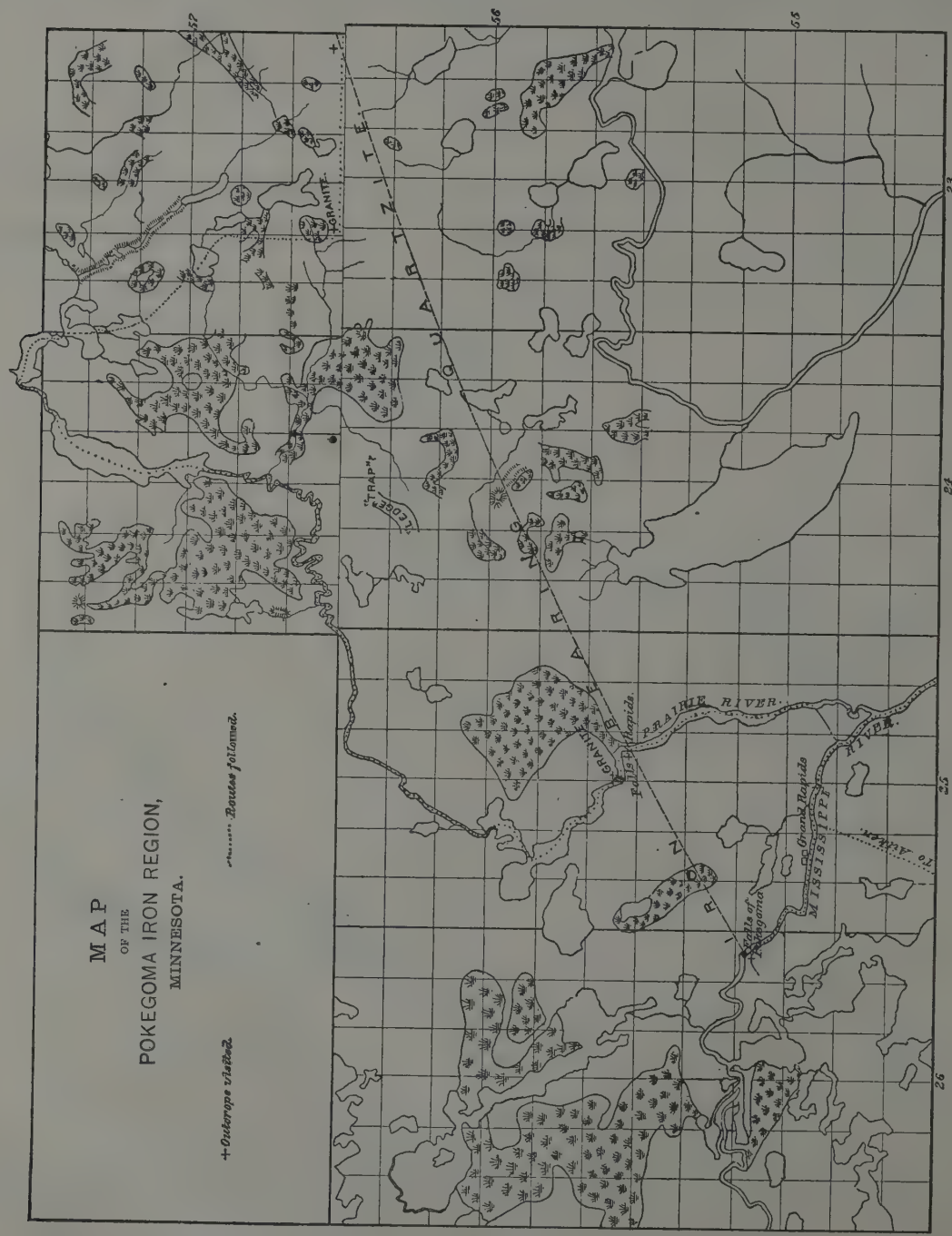


FIG. 904.

The strata forming the north shore of Lake Superior from Duluth eastward belong to the copper-bearing series. At Agate bay the outcrops on the shore consist of amygdaloid and other beds, frequently stained with the

green carbonate of copper. For six miles north of Agate bay the country is flat without any outcrops whatever, a but in Sec. 35, T. 54 N., R. 11 W., there is a small ravine, having a northeast southwest course, with precipitous sides of gabbro.

The northwest wall rises to a height of about 60 feet. It is more coarsely crystalline than the gabbro on the southeast, which only forms low bluffs 15 to 20 feet high. In this latter are little veins of magnetic ore and among the loose blocks at the foot were found several pieces of ore 1 foot to 18 inches thick. This magnetite forms a range that extends several miles northeast and southwest.

Sample 977 was taken from the loose blocks mentioned.

The following is the result of analysis: b

	AGATE BAY.
	977
	Per cent.
Metallic iron	51.71
Phosphorus	0.027
Phosphorus in 100 parts iron	0.052

Outline of trip on the Mississippi river. c

From Aitken to Grand rapids in T. 55 N., R. 25 W., by trail, 65 miles.

From Grand rapids to Sec. 36, T. 57 N., R. 23 W.. by way of Prairie river and Crooked lake, and return.

Grand Rapids to Aitken by canoe down the Mississippi, 155 miles.

From Aitken to Quodenong or Hill lake, about 45 miles, the trail leads through level bottom-lands, which are frequently marshy. The soil is a dark-colored vegetable mold, tough and elastic, like india-rubber, changing at times to a hard, fine, gray clay, without sand or pebbles. West of Hill lake are low drift ridges, and from there northward the surface is covered with boulders. The shores of Pokegoma lake, in places rising abruptly to a height of 25 or 30 feet, consist of sand- and clay-beds.

Three miles above Grand rapids, in Sec. 13, T. 55 N., R. 26 W., are the only outcrops seen on the Mississippi d north of Aitken. A ledge of red quartzite here forms the falls of Pokegoma, 12 feet in vertical height and about 250 feet long. This quartzite crops out along the south bank of the river for about 400 paces, and forms the backbone of a ridge 15 or 20 feet above the common level, which extends in a general course of north 70° to 80° east.

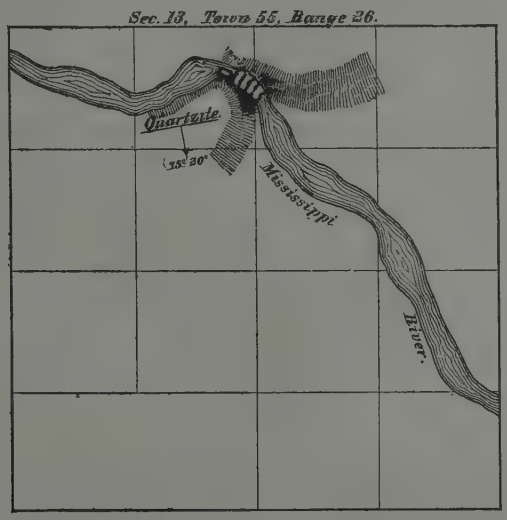


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FIG. 205.—SKETCH OF POKEGOMA FALLS, MINNESOTA.

Near the foot of the falls appears an incoherent sandstone, formed of coarse, rounded grains, cemented by oxide of iron, which overlies the quartzite and dips with it 15° to 20° south 10° east.

About 5 miles in a direction of north 60° east from Pokegoma falls are the Lower rapids of Prairie river. The fall is about 5 feet, and a quiet pool divides the two swift rushes of the water.

a The upper edge of the rapids is formed by a ledge of the same quartzite that is so prominent at Pokegoma falls; it also outcrops on the northern end of the portage trail. On both sides of the little basin and part way

b

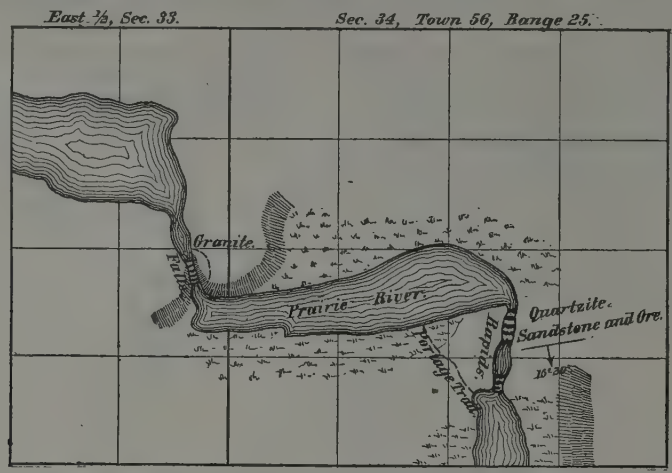

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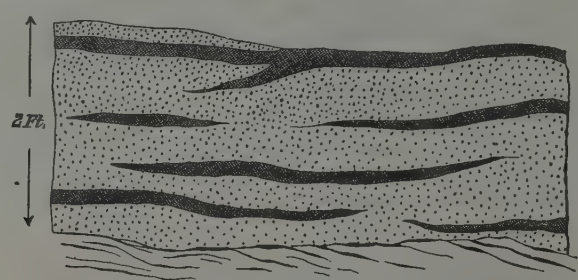
FIG. 206.—SKETCH OF THE LOWER RAPIDS, PRAIRIE RIVER, MINNESOTA.

down the lower half of the rapids are outcrops of coarse-grained sandstone, sometimes metamorphosed to a quartzite, irregularly interstratified with a steel blue, very hard specular ore, some specimens of which are strongly magnetic.

The following section (Fig. 207) was sketched just at the edge of the rapids:

d



Specular Ore in Sandstone, Prairie River.

FIG. 207.

e

A hundred feet east of the river is a small test-pit, in which the same sandstone and specular ore are exposed. The thickest layer of pure ore seen was about 3 inches. Sample 978 represents this ore, the associated sandstone not being included in it.

	978.
	Per cent.
Metallic iron	50.94
Phosphorus	0.012
Phosphorus in 100 parts iron	0.024

f

The above-described strata maintain the dip of the quartzite at Pokegoma falls, namely, 15° to 20° south, 10° east.

Prairie river, above the lower rapids, is a broad, quiet reach of water with marshy shores; but three-quarters of a mile west it falls 15 feet through a narrow channel cut in gray granite.

The narrow part of the river, from the foot of the falls to the lake above, is about a quarter of a mile in length. On both sides are bold outcrops of the fine-grained homogeneous gray granite, which shows no bedding, but is cut in all directions by many veins of coarsely crystalline pink feldspar and quartz.

From this point northward up Prairie river, through Crooked lake and across several hilly portages in T. 57, R. 23 W., nothing was seen but sand, clay, and loose boulders.

The first outcrops found consist of coarse red granite, which forms low ridges 15 to 20 feet high, separated by a swamps, on the southern line of T. 57 N., R. 23 W. This granite was not seen east of Sec. 35; and in the SE. corner of Sec. 36 the iron-bearing quartzite of the lower rapids of Prairie river rises in a steep bluff about 15 feet above the swamp.

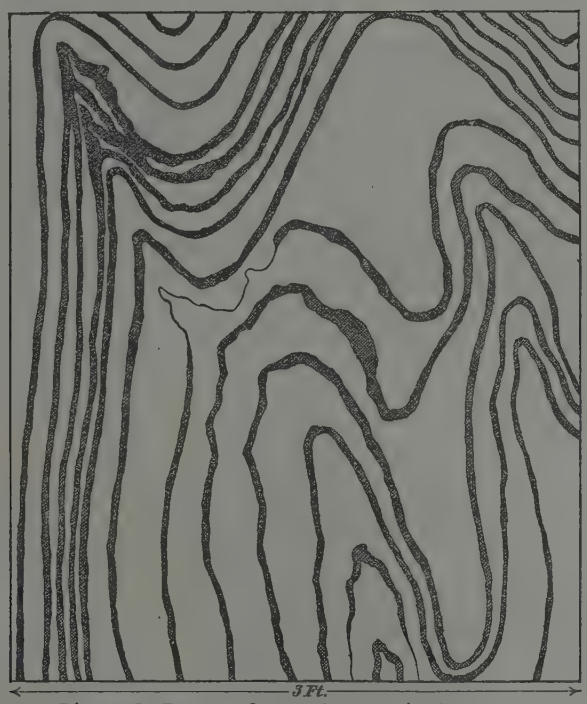
The iron ore occurs in thin layers as at Prairie river, but it is also more evenly distributed through the quartzite. The strata dips slightly to the south.

Outline of trip to Vermilion lake.

Duluth to Esquagama bridge, in T. 58 N., R. 15 W., trail 65 miles; through Esquagama or Embarrass lakes, across Wine portage and up Embarrass river to Big portage, 9 miles; Big portage from Embarrass to Pike river, b 4 miles; down Pike river to Vermilion lake, between 15 and 20 miles, with two portages. Returned by trail; 86 miles.

Narrative.—Between Duluth and the Cloquet river, a distance of 20 miles, there are frequent outcrops of the feldspathic rocks of the copper series. After crossing the Cloquet these disappear, and for 50 miles northward the surface is covered with heavy drift-beds. The abrupt slopes of the ridges descend sharply to swampy hollows, but there are no outcrops of rock in place. Much of the timber has been burnt off, and the huge boulders stand like houses amid the aftergrowth of birch and hazel.

At Wine Portage, 72 miles from Duluth, Embarrass river flows through a gap in Mesaba heights, in a series of rapids, three-quarters of a mile long. A cursory examination of the hill just east of the portage showed nothing c but drift. It is, however, probable that outcrops exist in this neighborhood, as the backbone of the range is said to consist of quartzite and magnetic iron ore, which have been traced by Professor Chester for 30 miles to the northeast.



Distorted Bands of Specular Ore in Jasper.

FIG. 208.

These heights are commonly called the "dividing ridge" between Hudson's bay and Lake Superior waters; but the true divide is the rolling plain of gravel and sand that is crossed by the Big portage between Embarrass and Pike rivers. The banks of the latter are grassy marshes, backed by an even line of tamaracks. As one approaches Vermilion lake outcrops of light-green highly silicious slate, frequently cut by veins of white quartz, are seen in a number of places along the river. They are especially prominent at a rapids about 2 miles from the lake and at Vermilion falls, which are near the mouth of the river. A very similar slate forms the shores of the lake at the Vermilion trading-post and Indian agency, and it rises in bluffs 50 feet above the marshes on the southern line of Sec. 32, T. 62 N., R. 15 W.

a As may be seen from the accompanying maps, the work of the party was confined to that part of this township south of the lake and west of sections 26 and 35. A reconnaissance survey was made with dial compasses* and watches, and pacing for distances. Lines were run thus one-eighth mile apart; all outcrops were noted, and at every 100 paces the variation and dip of the needle were observed. All belts of magnetic attraction discovered were traced.

In this area two interrupted ridges, 300 feet high, extend nearly due east and west, divided by a valley three-quarters of a mile wide. The principal hills consist of hard red jasper, flanked by lower points of black and white banded magnetic quartzite. They are girt by terraces of heavy drift, and the valley is a swamp, surrounding low drift mounds and outcrops of massive metamorphic rock. The northern and more extensive group of ridges is called b the "Vermilion range", the southern, the "Two Rivers range". Southeast from the Vermilion range, and separated from it by swamps, is Chester's peak, the abrupt end of a ridge, 500 feet high, which continues eastward beyond the limits of this survey.

Geology.—Dips throughout this area are between 85° and 90°, except in the northwestern outcrop of jasper on the Vermilion range. Observations at this one point afforded data for determining the relations of seven beds, as follows:

I. The lowest bed observed is a light-green, thinly laminated chloritic schist. It was only exposed at points on the anticlinal axes, and no estimate of its thickness is possible.

II. Jasper, made up of narrow bands of white, gray, brown, and bright red quartzite, interstratified with c layers of very hard blue specular iron ore, which also occurs in ore bodies of considerable superficial extent and in fissures that run across the bedding. The jasper hill summits are striated and highly polished by ice moving in the general direction of the strike. The planed edges of the bands illustrate the distortion suffered by the strata, and represent on a small scale the flexed condition of the entire series. See Fig. 208:

The thickness of the jasper, measured across apparently vertical dips, varies from 200 to 600 feet, or more. The smaller figure is probably nearer the truth.

d

e

Black Slate and Sandstone enclosed in Schist.

FIG. 209.

III is a chloritic schist, similar to that which underlies the jasper. At points in the synclinal, which is involved in the Two Rivers fold, it is massive, contains triclinic feldspar, and is cut by veins of white quartz. But as a rule I and III are so similar that it is only possible to distinguish them by reference to the adjacent strata. Being softer than the quartzites between which it lies, III varies in thickness according to the pressure it has been subjected to. The original thickness of deposition was probably about 150 feet.

f IV is a quartzite, banded in dark-gray, white, and black, and of saccharoidal texture. It contains grains of magnetite, irregularly distributed through it, which disturb the needle and produce the principal belts of magnetic attraction, indicated on the geological maps, Plates XXVII and XXXVIII, and on the magnetic chart, Plate XXXIX. This quartzite is probably about 200 feet thick. No ore of any value has been found in it.

Beds I to IV, inclusive, form the ridges. The sharp, conical outcrops of IV rise from the drift terraces which bound the swamps, and the contact between IV and V was only seen on the rocky point which extends into section 20.

V, VI, and VII are the valley rocks, and are intimately related.

V is a conglomerate, consisting of sandstone pebbles and bits of black slate inclosed in silicious chloritic schist (see Fig. 209). The major axes of the fragments lie parallel to the bedding of the schist. No very distinct line

* The form and method planned by Major Brooks for the Michigan geological survey.

Julius Bien & Co. Lith.

of contact was observed between V and VI, which is a compact homogeneous rock, composed of round quartz **a** grains, chlorite and hornblende, plagioclase feldspar, and a little calcite. It cleaves into pyramidal and prismatic blocks, is a light-gray color on the weathered surface, and but little darker on the fresh fracture. Should this rock be proved eruptive it belongs to the quartz diorites; but I consider it a metamorphosed sedimentary bed of transition from the conglomerate below.

VII. A black clay slate. This slate is very fissile and sonorous. It occupies a broad area north of the Vermilion range; was not seen in the valley south of it, but forms a singular outcrop on the western end of the Two Rivers range, in close proximity to a peak of the quartzite IV. Its presence here implies a sudden downward pitch of the axes of the Two Rivers fold, but is difficult to explain with only the facts now known. The layers of slate in this outcrop are pierced with square holes left by the decomposition of crystals of pyrite, which are lined by a deposit **b** of silica, apparently formed around a smaller crystal, as the holes within are sharply angular.

The Vermilion and Two Rivers ranges are anticlinal ridges, eroded to the soft, chloritic schist, I. In the former range the spring of the jasper arch is thus left on either side, the southern being the higher, and the schist forming a hollow or gentle slope north of it.

Through Sec. 28 huge masses of jasper from the crown of the arch remain imbedded in the green schist, with which they agree in strike and vertical dip. These jasper blocks are rectangular and several hundred feet long; the ends of the bands come out squarely to the contact with the schist, as to a fault. These contacts represent, in fact, short fractures at right angles to the axis, between which blocks from the crown of the arch were bent downward, forming cut-off synclinals in the top of the anticlinal. The depressed portions of the jasper have thus **c** escaped the erosion suffered by the crown. A similar inlaying of III in II was observed in the Two Rivers range. The outcrop of the jasper arch, where it pitches westward under the surface, forms a hook-shaped ridge and gave the key to the structure, as may be seen on examining the dips on the magnetic chart in the NW. ¼ of Sec. 28. West of this the quartzite, IV, forms the ridge, and the intermediate schist, III, presumably underlies the drift

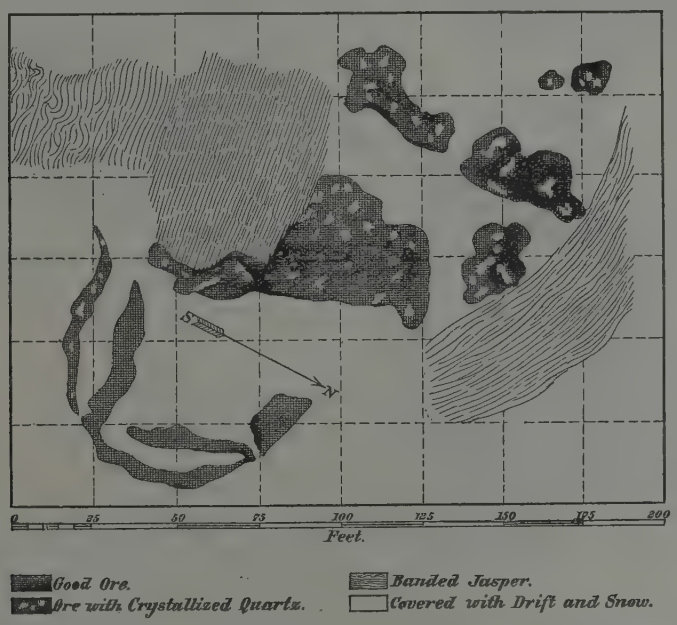


FIG. 210.—SKETCH-MAP OF AN ORE BODY ON THE TWO RIVERS RANGE, MINNESOTA.

between the outcrops. On the south side of the Vermilion range a small fold brings the jasper to the surface **f** through the overlying schist, and it contains a large ore-body at this point. Near the line between Secs. 27 and 28 the jasper is very much contorted, and the great thickness, which here forms the highest part of the Vermilion range, is due to crumpling of the bed. On the north side of the arch the jasper ridge is low and the outcrops are not continuous, being frequently drift-covered. South of Morrison's bay there are cliffs of "slate ore", a variety of jasper which cleaves readily parallel to the bedding into thin sheets, and is lined with specular ore on the cleavage planes.

The Two Rivers range consists almost wholly of the flexed jasper on the southern side of the main anticlinal, the northern being represented by but two narrow outcrops in the valley. The lower schist, I, was identified as such by inlaid masses of jasper similar to those on the axis of the Vermilion range. The jasper lip of the involved synclinal, just west of the line between Secs. 32 and 33, contains a considerable body of specular ore. South of

a it is the subordinate anticlinal, and beyond that the jasper ridge, with its outlying pinnacles of the black quartzite, IV, which stand on the edge of the drift terrace. The two lines of IV north of the range were each located by a single outcrop and by magnetic attraction, traced through the swamp. The dislocation of the more southerly of these belts, proven by sudden change of strike, is accompanied by a corresponding jump of the belt of magnetic attraction. The northern line of attraction follows the crown of an arch, which separates the area between the Two Rivers and Vermilion ranges into two troughs of unequal widths.

Plate XXXVII gives the outcrops observed, the spaces left white having been covered with deep snow and drift.

Plate XXXVIII shows the structure deduced from these observations.

Plate XXXIX gives Mr. Fay's magnetic notes in detail, and illustrates the relation of the principal lines of b magnetic attraction to the quartzite, IV, and in a less degree to the jasper, as well as the fact that they are in no way connected with the known bodies of valuable ore.

I was told by the surveyors at work in the townships east of Vermilion—namely, T. 62 N., R. 13 and 14 W.—that the variation changes rapidly from point to point, as it does in T. 62 N., R. 15 W., and that the only outcrops seen consist of jasper and quartzite. The surface is covered with a dense growth of pine, and the strata are hidden under moss and thick underbrush. Burnside lake, 12 miles east of Vermilion, is said to contain many rocky islets, consisting principally of jasper.

NOTES ON THE OCCURRENCE OF IRON ORE.

c During the summer of 1880 the iron ores of this locality had been examined by Professor A. H. Chester, who stripped the jasper beds wherever the outcrops showed a considerable proportion of ore. Many of these trenches were filled with water and could not be examined. The following notes state what could be ascertained:

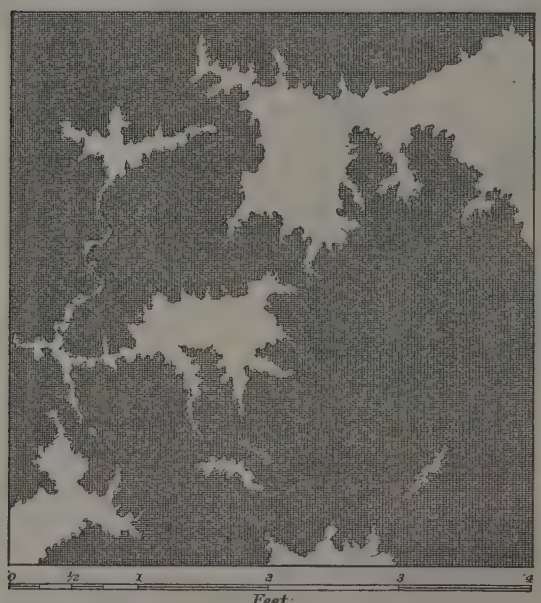


FIG. 211.—CRYSTALLIZED QUARTZ IN SPECULAR ORE, TWO RIVERS RANGE, MINNESOTA.

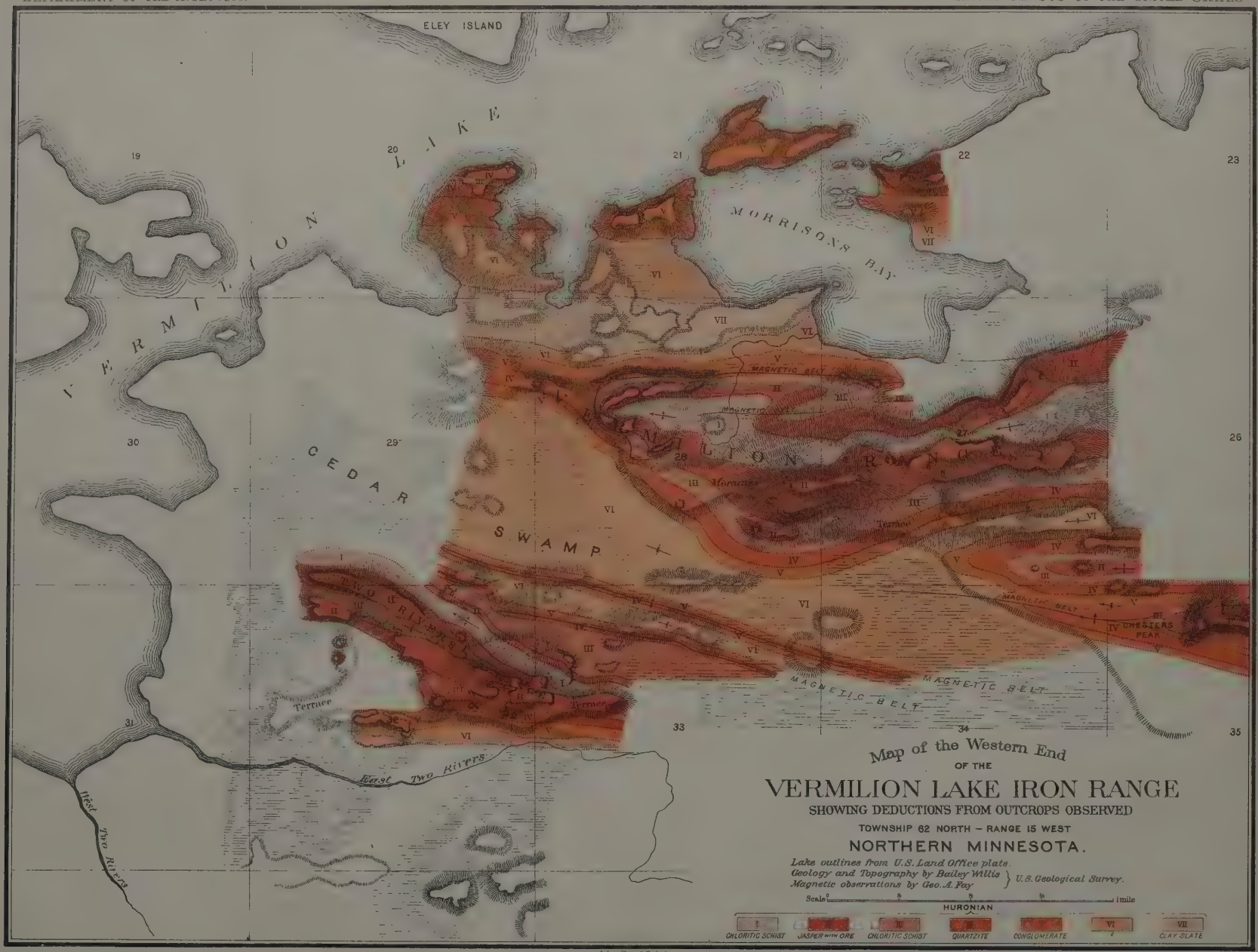
The ore-bodies of the Two Rivers range are confined to its eastern end. In Sec. 33, on the eastern slope of jasper, six trenches exposed a surface 100 paces long, east and west, by 20 to 60 paces wide, north and south. The southern end of these trenches was sunk to the contact with the chloritic schist, III. But one of these test-pits exposed any good ore d free from large admixtures of jasper and crystallized quartz, and that was of small surface area. It is a slaty, specular ore, softer and less crystalline than that found elsewhere in the range. The analysis of sample 980, taken by chipping along the trench, gives—

	980.
	Per cent.
Metallic iron	65.89
Phosphorus	0.044
e Phosphorus in 100 parts iron	0.067

The largest body of ore seen in the Two Rivers range lies in the fold of the synclinal in Sec. 33, near the line of Sec. 32. Fig. 210 shows its association, the white areas having been covered with drift or snow. The ore is a homogeneous steel-blue specular, inclosing many cavities lined with brilliant micaceous crystals. It is exceedingly hard, and associated with crystallized quartz. In that marked good ore in Fig. 210 no quartz could be detected by the eye. The character of the other portions of the ore is indicated in Fig. 211.

Sample 979 was taken by chipping in three lines across the outcrop of good ore. The other parts would yield f similar results if carefully hand-picked:

	979.
	Per cent.
Metallic iron	66.46
Phosphorus	0.044
Phosphorus in 100 parts iron	0.066



Julius Bien & Co Lith.

This ore was followed westward in a number of test-pits. Near the section line it has a width of 24 feet, with but little quartz. A hundred paces west of the section line a bluff exposes a vertical section given in Fig. 212. A little farther westward three trenches cross an ore-body 75 feet long and from 2 to 16 feet wide.

FIG. 212.—VERTICAL SECTION IN THE TWO RIVER RANGE, MINNESOTA, SHOWING SPECULAR ORE IN BANDED JASPER.

On the southern slope of the Vermilion range, in the southeast corner of Sec. 28, a large body of ore forms a prominent bluff. It lies in the synclinal, where the jasper appears through the schist, III, and the ore crops out

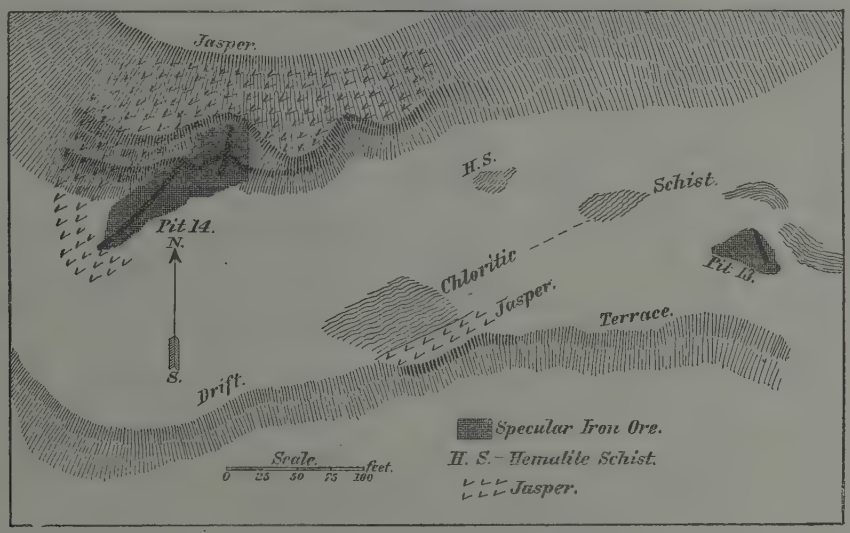


FIG. 213.—SKETCH MAP OF AN ORE BODY ON THE VERMILLION RANGE, MINNESOTA.

north and south of the schist as shown in Fig. 213. It may probably be continuous between pits 13 and 14.

Sample 981 represents the average composition of the very hard, crystalline, steel-blue ore:

	981.
	Per cent.
Metallic iron	68.05
Phosphorus	0.056
Phosphorus in 100 parts iron	0.082

The hill 200 paces west of this, which is probably in the same fold, contains curious masses of ore in angular fragments cemented by pyrite. These have no commercial value.

The other ore-deposits of consequence in the Vermilion range, three in number, occur in the jasper, south of the anticlinal, in Sec. 27.

The first of these is near the line between Secs. 27 and 28. It is opened in two trenches 75 feet apart, and has a width of about 25 feet. The ore is schistose and softer than that of the other deposits, and is mingled with jasper.

a Sample 982 represents the average ore from both pits:

	982.
	Per cent.
Metallic iron	64.55
Phosphorus	0.035
Phosphorus in 100 parts iron	0.054

An eighth of a mile farther east the much-contorted jasper contains a large proportion of ore, which led to
b digging the trench shown in Fig. 214. The extent of this ore-body was hidden by the snow, but the width in the

c

d

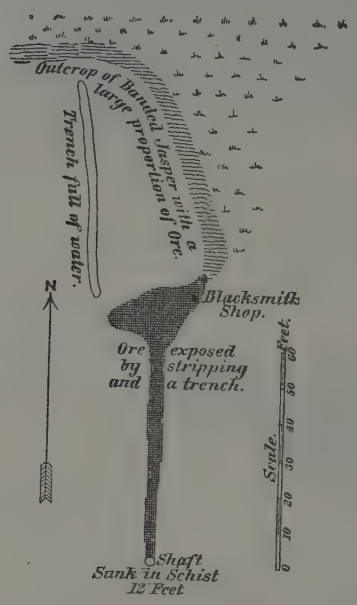


FIG. 214.—SKETCH MAP IN THE VERMILLION RANGE, MINNESOTA.

trench was 70 feet. Sample 983 represents this ore:

	983.
	Per cent.
Metallic iron	67.28
Phosphorus	0.059
Phosphorus in 100 parts iron	0.088

Still eastward from this pit the jasper outcrops contain a large proportion of ore, and the most eastern test-pits expose the largest area of good ore seen on the range (see Fig. 215).

f

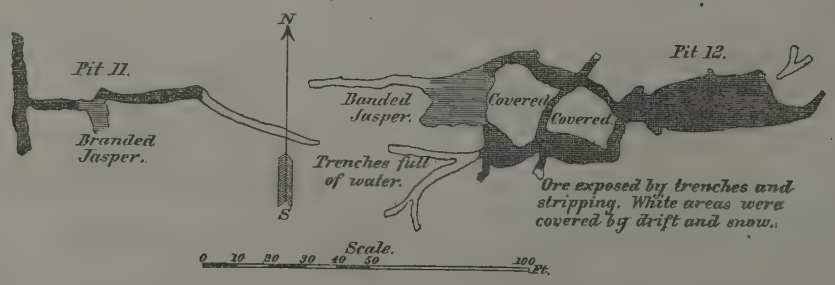
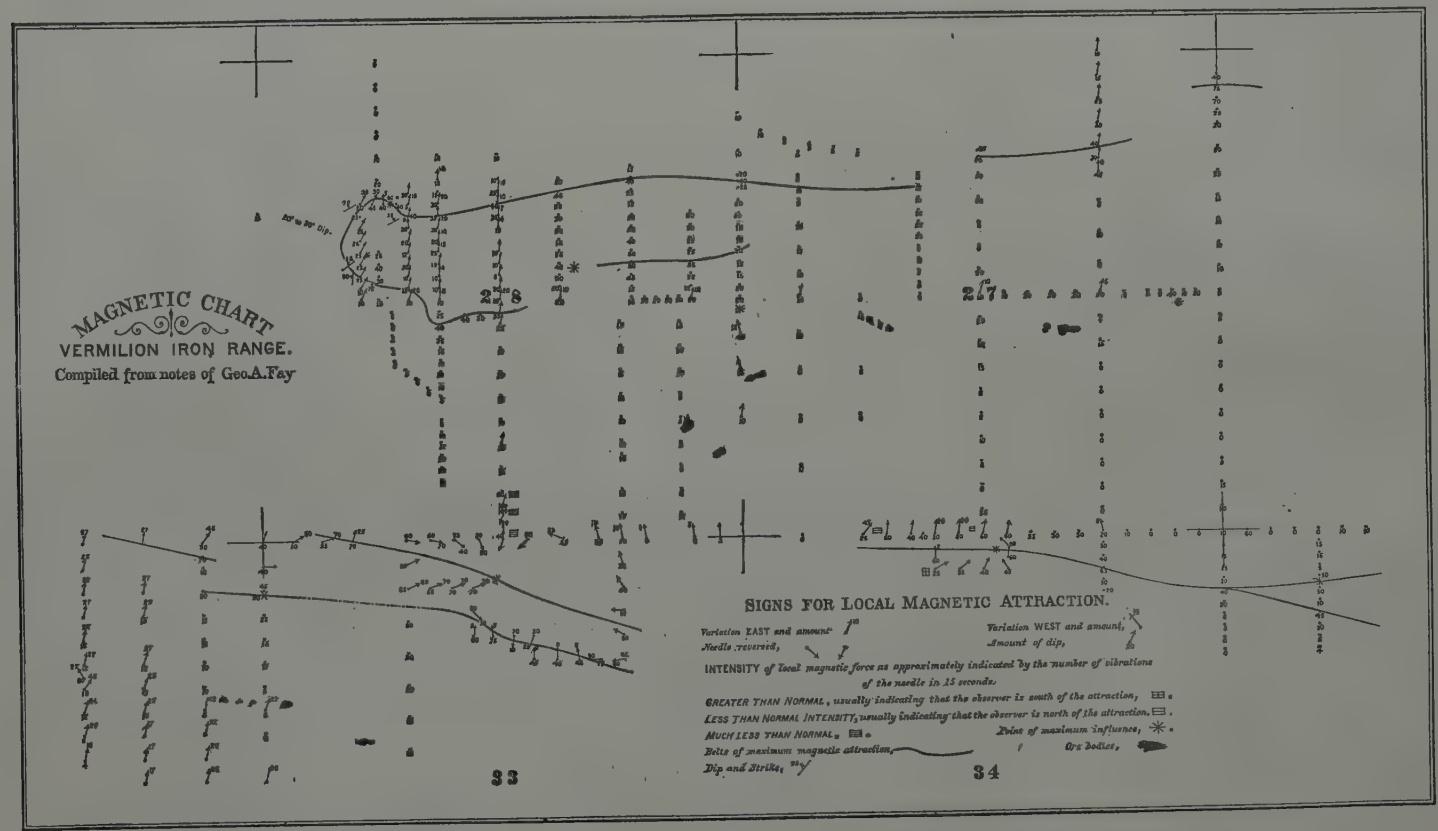


FIG. 215.—SKETCH OF AN ORE BODY OF THE VERMILION RANGE, MINNESOTA.


MAGNETIC CHART
VERMILION IRON RANGE.
Compiled from notes of Geo. A. Fay
SIGNS FOR LOCAL MAGNETIC ATTRACTION.
Variation EAST and amount,
Needle reversed,
Variation WEST and amount,
Amount of dip,
INTENSITY of local magnetic force as approximately indicated by the number of vibrations of the needle in 15 seconds.
GREATER THAN NORMAL, usually indicating that the observer is south of the attraction,
LESS THAN NORMAL INTENSITY, usually indicating that the observer is north of the attraction.
MUCH LESS THAN NORMAL.
Point of maximum influence,
Belts of maximum magnetic attraction,
Ore bodies,
Dip and Strike,
33
34

The ore is hard, crystalline, and free from quartz-masses. Sample 984 represents the average of the entire a ore-surface:

	984.
	Per cent.
Metallic iron	65.73
Phosphorus	0.067
Phosphorus in 100 parts iron	0.102

The ore-bodies described all appear to lie in folds or crumpled portions of the very much disturbed strata. The suggestion they thus give may serve as a hint to prospectors able to unravel the complicated structure of this b iron-bearing series in its eastward extension.

Drift phenomena do not properly belong to this paper, but I wish to call attention to the two parallel drift-ridges that lie on the western slope of the main Vermilion ridge, in the southeast part of Sec. 28. They are about one-eighth mile long, perhaps 20 feet high, and between them is a hollow not much larger than one of the ridges.

MAP
SHOWING LOCATION
OF THE
DEPOSITS OF IRON ORE
West of the 100th Meridian.
BAYARD T. PUTNAM.
REFERENCE.
MAGNETIC ORE.
SPECULAR ORE AND HEMATITE.
LIMONITE.
CARBONATE AND DERIVATIVES.
FURNACES.
MINNESOTA
DAKOTA
MONTANA
WYOMING
NEBRASKA
COLORADO
UTAH
NEVADA
ARIZONA
NEW MEXICO
TEXAS
WASHINGTON
OREGON
CALIFORNIA
LOWER CALIFORNIA
SONORA
CHIHUAHUA
PACIFIC OCEAN
GULF OF CALIFORNIA

FIG. 216.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED WEST OF THE ONE HUNDREDTH MERIDIAN.

By Bayard T. Putnam. c

In a country so sparsely settled as is that portion of the United States west of the 100th meridian, and one in which, moreover, transportation is so expensive, and suitable fuel as a rule is so scarce, it is not strange that little has thus far been done to develop the iron resources of the region or even to determine the extent of those resources. In the published reports of the government surveys, etc., of the West, iron-ore is but seldom mentioned, and the references made to it are as a rule either to masses of ore, such as those found in southwestern Utah, Sierra county, California, etc., which must of necessity at once have attracted the attention of the traveler, or to the seams of partially-altered carbonate ore, usually associated with beds of lignite and coal. d

The smelting of iron ore has not, however, been left entirely untried. Lesley, (a) in 1859, speaks of a reported forge in Utah, using ore found in the mountains east of Salt Lake City, and also says: "One or more forges are spoken of on the West coast, but nothing is known of them." The report of a forge near Salt Lake City is probably an error, and the rumor is doubtless explained by the fact that a few pounds of ore were there worked into iron in a blacksmith's forge. The California forges I have been able to find no other reference to.

The extraordinary masses of ore in Iron county, Utah, are situated but a few miles from the old Mormon settlement of Cedar City, and must therefore have been known to the first immigrants. Iron is said to have been produced from this ore as early as 1852, but nothing beyond the mere statement of the fact appears in any of the reports of that region which I have seen. Iron City was founded about 1869, and a small charcoal blast-furnace, puddling-furnace, foundery, etc., erected there by the Great Western Iron Company, of which John W. Young was e president. Some iron was made between 1869 and 1875, but the experiment was not financially a success, and since the latter date (or possibly 1876) the works have been idle. In December, 1880, the population of Iron City consisted of one family. The blast-furnace is 19 feet high, 4 feet wide at the boshes, and was planned to make 5 tons of pig-iron daily. The fuel used was charcoal, made from the cedar which covers the surrounding hills. It was burnt in piles. Two large beehive kilns were built near the furnace, during the last year that the latter was in operation, but they have never been used. The iron made was used principally for shoes and dies for stamp-mills, and was teamed to different parts of the territory and to Nevada, where it is said to have given good satisfaction. I was unable to obtain any detailed statement in regard to the working of the furnace, but I understand that difficulty was experienced in puddling the iron, and but little if any soft iron was made. Something like $150,000 was expended before the works were abandoned. The property is now owned by Thomas Taylor, of Salt Lake f City. The ore will be described hereafter.

Probably the honor of making the first pig-iron west of the 100th meridian belongs to Colorado. In 1864 a small blast-furnace was built by Mr. Marshall, near what is now the Marshall coal mine, on South Boulder creek, Boulder county, 5 miles south of the town of Boulder, to smelt the nodular pieces of partially-altered carbonate, derived from a thin seam in the coal formation through the erosion and degradation of the inclosing rock, which here covered the plains in large quantities. The stack which was built from the sandstone overlying the coal was designed to make 5 tons of pig iron a day. The fuel was charcoal made from the pine, etc., in the foot-hills 4 miles away. Limestone was also brought from the foot-hills. The blowing-engine was of wood, and was driven by a 25-foot overshot water-wheel. The furnace was in operation for about two and a half months in the summer of 1864,

a *The Iron Manufacturer's Guide*, p. 217.

a and made some 200 tons of pig-iron, which was used for mill purposes with good results; but the cost of producing the iron was too great, and the furnace has been idle since its first run. The stack is still standing, and the blowing-machinery has not been disturbed, and is in good condition.

In Oregon a company was incorporated in February, 1865, under the name of the Oregon Iron Company. In 1866 the erection of a furnace and the necessary buildings was commenced at Oswego, Clackamas county, a small village on the west bank of the Willamette river, 7 miles above (south of) Portland. The stack is of stone, and was erected under the direction of Mr. G. D. Wilbur, of Connecticut, after the plan of the Lime Rock furnace, in Litchfield county of that state. The rock used is basalt, from the neighborhood. The furnace was completed in June, 1867, but did not immediately go into blast on account of some difficulty in obtaining a sufficient quantity of b charcoal. The destruction of some of the buildings by fire on the night of July 2d further delayed matters, and it was not until the 24th of August (1867) that the first cast of pig-iron was made. The stack as originally built was 32 feet high and 9½ feet in diameter at the boshes. Its height was increased to 42 feet in 1869. The blast-producing machinery was driven then, as it is now, by a turbine water-wheel. The blast was heated. In the first run the furnace produced from 6 to 8 tons of pig iron a day. By the 1st of October 224 tons (gross) had been made at an average cost of $28 98 per gross ton, the cost being distributed as follows: (a)

166 bushels of charcoal, at 8 cents, $13 28; 884 pounds lime, at 40 cents, $3 53; 4,970 pounds ore, at $2 50 a ton, $5 50; labor, etc., $6 67; total, $28 98.

The ore was obtained chiefly from the Prosser mine (see samples 1165 and 1167), 2½ miles distant, whence it c was teamed to the furnace. A little Patton ore (sample No. 1166) was also used. The conditions for a commercial success so far as natural advantages were concerned seemed to be here well fulfilled, but the project was not financially remunerative, and after sinking several hundred thousand dollars the Oregon Iron Company put the furnace out of blast. It was idle for some years, but was bought for a fraction of its original cost in 1878 by its present owners, who are known as the Oswego Iron Company. The stack was raised to 44 feet, and in the spring of 1880 a new blowing-engine (horizontal, two cylinders, each 4 feet in diameter and 5-foot stroke, built in Portland) and a new turbine-wheel were put in. Arrangements were also made to complete a canal, begun by the old company from the Tualitin river to Sucker lake. It is from the latter that the water is drawn to drive the turbine, and in some seasons of the year the lake is too low to supply the necessary head. When the canal is completed the lake can probably be kept full at all times. A narrow-gauge railroad was completed to the Prosser mine in August, d 1880, and the cost of the ore at the furnace will, therefore, be much reduced hereafter. The company owns about 3,000 acres of timber-land, principally fir, which, it is said, will cut on an average 100 cords to the acre. The charcoal has been heretofore all made in heaps, but kilns are now being constructed. Estimating the value of the stumpage at 10 cents per cord, and the price of cutting at 90 cents, the total cost of the coal delivered at the furnace is between 6 and 7 cents a bushel. Much of the wood, it is claimed, will make 50 bushels of coal to the cord.

No limestone is found in the neighborhood, and this is the most serious drawback which the furnace company has to meet. That now used is brought from Puyallup valley, in Washington territory, and costs at the furnace $5 50 to $6 per ton.

The ore, as will be more fully mentioned hereafter, is a limonite. Its yield in the furnace is indicated by the e following statement: On January 12, 1881, the furnace-charge was—

Prosser ore (see samples Nos. 1165 and 1167)	pounds	1,000
Patton ore (see sample No. 1166)	do	100
Limestone	do	55
Charcoal	bushels	25

There are 112 charges every twenty-four hours; hence in that time there are used in the furnace 61.60 tons (2,000 pounds) of ore, 3.08 tons of limestone, and 2,800 bushels of charcoal. The product is about 24 net tons of pig-iron. Hence, first, the mixture of ores yields about 40 per cent. pig-iron in the furnace; second, it takes 128 bushels of charcoal to make 1 ton of pig-iron. The latter figure appears to be higher than is the average rate of charcoal consumption for the year. The present yield of the furnace per twenty-four hours is also greater than it has heretofore been. The production of pig-iron in 1880 was 5,000 net tons.

f A furnace was built at Ogden, Utah, in 1875, by the Ogden Iron Manufacturing Company, and was lighted in the fall of that year. It froze up, however, before the iron came down, and has been idle since. The stack is of the crinoline pattern, 45 feet high and 12 feet in diameter at the boshes, and is provided with a water-balance elevator. The blast-producing machinery consists of three horizontal blowing-cylinders, each 21 inches in diameter, with a 72-inch stroke. The original plans included a puddling furnace, rolling-mill, foundery, etc., and much of the necessary machinery is now on the ground, but has never been set up. Power for the whole works was to have been supplied by two 48-inch turbine water-wheels.

I could not learn definitely the cause of the failure of this enterprise, but it is evident that the plan of using the raw Wyoming coals, which was the fuel proposed, could not have been successfully carried out. My own

a Report of J. Ross Browne on the Mineral Resources of the States and Territories West of the Rocky Mountains, 1868.

impression is, too, that the ores used in the experiment were lean and silicious, and would work with some difficulty a in any event. That there was ignorant management somewhere is too apparent to require mention. The furnace and other property of the old company has been purchased by the Equitable Iron and Coal Company, incorporated under the laws of Utah January 1, 1878, but, so far as known to me, the works still remain idle.

The year 1880 witnessed the beginning of three blast-furnaces in the West—one in Colorado, one in California, and one in Washington territory.

The Washington territory furnace was started after the other two, but went into blast first. It is located at "Irondale", on the west shore of Port Townsend bay, about 3½ miles in a direct line from the town of Port Townsend. The foundation of the furnace was laid in August, 1880, fire was started in January, 1881, and the first cast was made on January 25, 1881. The campaign lasted until November 10, 1881, during which time about 1,300 b tons of pig-iron were made. The stack is of brick bound with 15 iron hoops and 8 vertical braces. Its dimensions are as follows: Height, 32 feet; diameter at the boshes, 9½; diameter at throat, 3 feet; diameter at hearth, 2 feet; section of hearth, square; height of boshes above bottom of crucible, 12 feet; angle of boshes, 65°. Top of furnace is covered with stack 28 feet high (above charging floor). There are three tuyeres, each having a 4-inch aperture at nozzle. The height of center of tuyeres above bottom of crucible is 23 inches. The gases are taken off through four openings, each 9 inches by 15 inches, connecting with a flue which passes entirely around the upper part of the furnace. They are conveyed by a 20-inch iron pipe to the oven, which is built on the ground. The oven contains 32 6-inch pipes, each 5½ feet long. There were used in the furnace-stack alone 120,000 red brick and 21,000 fire brick, and in the works altogether 165,000 red brick and 30,000 fire-brick. c

The ore is of two kinds, a bog-ore dug in Chimicum valley, 2½ miles from the furnace (sample No. 1168), and magnetic ore from Texada island, British Columbia (sample No. 1169). Limestone is obtained from Orcas island, at a cost of $2 a ton. Charcoal is made near the furnace. The works are the property of the Puget Sound Iron Company.

The California Iron Company commenced the erection of a charcoal furnace in the spring of 1880, in Placer county, 3 miles from Clipper gap, and 7 miles from Auburn (both stations on the Central Pacific railroad, in the western foot-hills of the Sierra Nevada mountains). The stack is 47 feet high, 10 feet diameter at the boshes, and is inclosed in an iron shell supported on iron pillars. It is provided with a water jacket and six tuyeres, and is modeled after a furnace in Menominee, Michigan. The first cast was made on April 24, 1881. The works are located within a few hundred feet of a deposit of manetite ore of unknown extent (samples No. 1170 and 1171), d and within a few miles of what appears to be a large mass of limonite (sample No. 1172). The latter is referred to in *Whitney's Report of the Geological Survey of California*, Vol. I, p. 284, and the remark is there made that this locality is perhaps more favorably situated than any yet discovered in the state for trying the experiment of iron-smelting. The foot-hills are plentifully supplied with wood for charcoal. The company has erected twenty beehive kilns in which to burn the coal.

The extensive iron- and steel-works of the Colorado Coal and Iron Company were begun in the spring of 1880, and one stack was completed and put into blast in September of the following year. The works are situated on the mesa at South Pueblo, near the main track of the Denver and Rio Grande railroad. The full plans include two blast-furnaces (crinoline pattern), each 15 by 65 feet, two Bessemer converters, a complete rail- and merchant-mill plant, foundery, etc. If finished according to these plans, this will be as complete an iron establishment as e any in the country. Coke manufactured at El Moro, by the company, is used as fuel. The ores are brought from different parts of the mountains. Limestone occurs in the foot-hills near by.

In 1873 a furnace was projected by the Sierra Iron Company of California, to work the large masses of magnetic ore existing in Sierra and Plumas counties, but the works were never really begun, owing in part at least to the failure to build a proposed railroad from Reno, Nevada, to Oroville, California, which would have passed near the iron mines.

The Norway Iron Mining and Manufacturing Company of Utah was incorporated under the laws of that territory in November, 1879. The company owns property in Morgan county, 10 miles from Weber station, on the Union Pacific railroad, where, it is claimed, deposits of good iron ore have been discovered. The company propose to erect a 10-ton furnace near the mines, but have not as yet begun actual buidling. f

The following list of the iron-smelting establishments west of the 100th meridian contains some data omitted from the foregoing brief sketch:

California.—California Iron Company, Clipper Gap, Placer county. One stack 47 by 10 feet; iron shell; water-jacket; six tuyeres. Begun in 1880. First cast of iron on April 24, 1881; fuel, charcoal; ore, magnetite and limonite from vicinity of furnace. Manager, P. Fitzhugh.

Colorado.—Colorado Coal and Iron Company, South Pueblo, Pueblo county. One stack 65 by 15 in blast, and plans made for a second. Complete Bessemer rail-mill plant in process of construction. First cast of pig-iron, September, 1881. Fuel, coke. Officers of company: President, William J. Palmer; vice-president, Charles B. Lamborn; secretary and treasurer, Walter B. Gaskill; general agent, W. G. Brown.

a *Oregon.*—Oswego furnace, Oswego Iron Company, Oswego, Clackamas county. One stone stack 44 by 9½ feet; open-top hot blast; water-power; fuel, charcoal. The furnace was built in 1866–1867 by the Oregon Iron Company. First cast, August 24, 1867. The present owners came into possession in 1878. The officers of the Oregon Iron Company were: President, W. S. Ladd; vice-president, H. G. Leonard; secretary, H. D. Greene. The officers of the Oswego Iron Company are: President and treasurer, S. H. Brown, 220 Front street, Portland; secretary and superintendent, E. W. Crichton, Oswego; agent, L. B. Seeley, Main and Folsom streets, San Francisco.

Utah territory.—Great Western Iron Works, Iron City, Iron county. One small charcoal stack, puddling furnace, etc. Built about 1869. Idle since 1875 (or 1876). Now owned by Thomas Taylor, of Salt Lake City.

Equitable Iron and Coal Company, Ogden. One stack 45 by 12; built in 1875, but has made no iron. Officers b of company: President, E. H. Orth; general manager, James D. Kase; secretary, George F. Brown.

Norway Iron and Manufacturing Company, Salt Lake City. Projected charcoal furnace in Morgan county. Officers of company: President, John F. Lynch; vice-president, Charles Popper; treasurer, Frederick G. Lynberg; secretary, B. A. M. Froiseth.

Washington territory.—Puget Sound Iron Company, Irondale, Port Townsend bay. One brick stack 32 by 9½ feet; begun in 1880. First cast January 25, 1881. Fuel, charcoal. Ores, bog-ores found in vicinity of furnace, and magnetite from Texada island, British Columbia. Officers of the company: President, John A. Paxtine; vice-president, John H. Redington; treasurer, Charles H. Simpkins; secretary, A. Holsey.

In the autumn of 1880 the writer was directed by Professor Pumpelly to visit and sample, so far as time would c permit, the known deposits of iron ore west of the 100th meridian. The following notes embrace descriptions of the samples collected: (*a*)

IRON ORES IN COLORADO.

Magnetite in the Archæan.—Magnetite exists in the Archæan rocks throughout the Rocky mountains. All the samples collected contain titanic acid, in some cases in such large quantities as to render the ore unfit for use in the blast-furnace, excepting when mixed in small amounts with other ores. The attempts which have been made at several points to use this ore for flux in lead-smelting have proved failures.

The largest mass of magnetite thus far discovered in Colorado is known as *Iron mountain.* It is a hill about d 800 feet long, 500 feet wide, and 60 feet high, situated in Wet Mountain valley, Fremont county, about 1 mile north of the upper end of Pine Creek cañon. Pine creek is a tributary to Grape creek, and the latter empties into the Arkansas river near Cañon City. A branch of the Denver and Rio Grande railroad has recently been completed between Cañon City and Silver Cliff, which passes along Grape creek, and from this Iron mountain is but about 4½ miles distant. Preliminary surveys have already been made for a spur-track through Pine Creek cañon to the ore-deposit. By this route the distance to Cañon City is about 22 miles, and to the steel-works at South Pueblo 65 miles. By road from Cañon City, through Grape Creek cañon, across Webster park, and through Webster cañon (sometimes called Copper gulch), the distance to Iron mountain is about 21 miles. Iron mountain is 8,000 feet above the level of the sea, and 2,500 feet above Cañon City. On the proposed railroad route there is a continuous down-grade from the former to the latter point (see Fig. 217).

e The existence of iron ore here has been known for many years. It was referred to by Mr. Endlich, (*b*) in 1873, who states that the ore was then being mined. In 1875 the locality was visited by M. Chaper, ex-secretary of the Geological Society of France. Extracts from his report, with analyses of the ore made at the School of Mines, Paris, were printed in the *Fifth annual report of the board of directors of the Colorado Improvement Company* (1877–1878). A United States patent for the land was obtained in 1872. The property now belongs to the Colorado Coal and Iron Company. On the accompanying sketch-map (Fig. 218), which indicates closely the general size and shape of the hill, are recorded the results of a series of dip-needle observations. A line was marked out over the hill in the most convenient locality, and along it stakes were placed at intervals of 100 feet. From each of these stakes lines were run in either direction at right-angles with the main line, and along these cross-lines the angle of the dip was noted at points five paces apart. The "base line" was measured with a tape. Its direction (true) is f about north 6° east. The cross-lines are numbered on the map from 1 to 9, beginning at the south. The day the magnetic survey was made the hill was covered with 3 or 4 inches of snow. Much of this had melted by the following morning, so that the outcrops of ore could be located. The direction of the two main ridges of the hill is

a Montana, Idaho, and eastern Washington territory were not visited owing to the difficulty of transportation in that region in the winter season at that time. The work of the Northern Transcontinental survey has since proved the existence of extensive deposits of iron ore in the mountain region of Montana. Notable amongst these is a mass of magnetic ore in crystalline rocks on East Boulder creek, Gallatin county, and one in Lower Palæozoic quartzites (?) on Cable mountain, Deer Lodge county. The ore from the outcrop at the latter locality will average from 55 to 60 per cent. metallic iron, is low in phosphorus and sulphur, and practically free from titanium. It is therefore an excellent Bessemer ore. As situated it is not difficult of access, and as soon as there is a sufficient demand for iron in Montana it will doubtless prove valuable.

b *Annual Report Geological and Geographical Survey of the Territories for* 1873, by F. V. Hayden, p. 333.

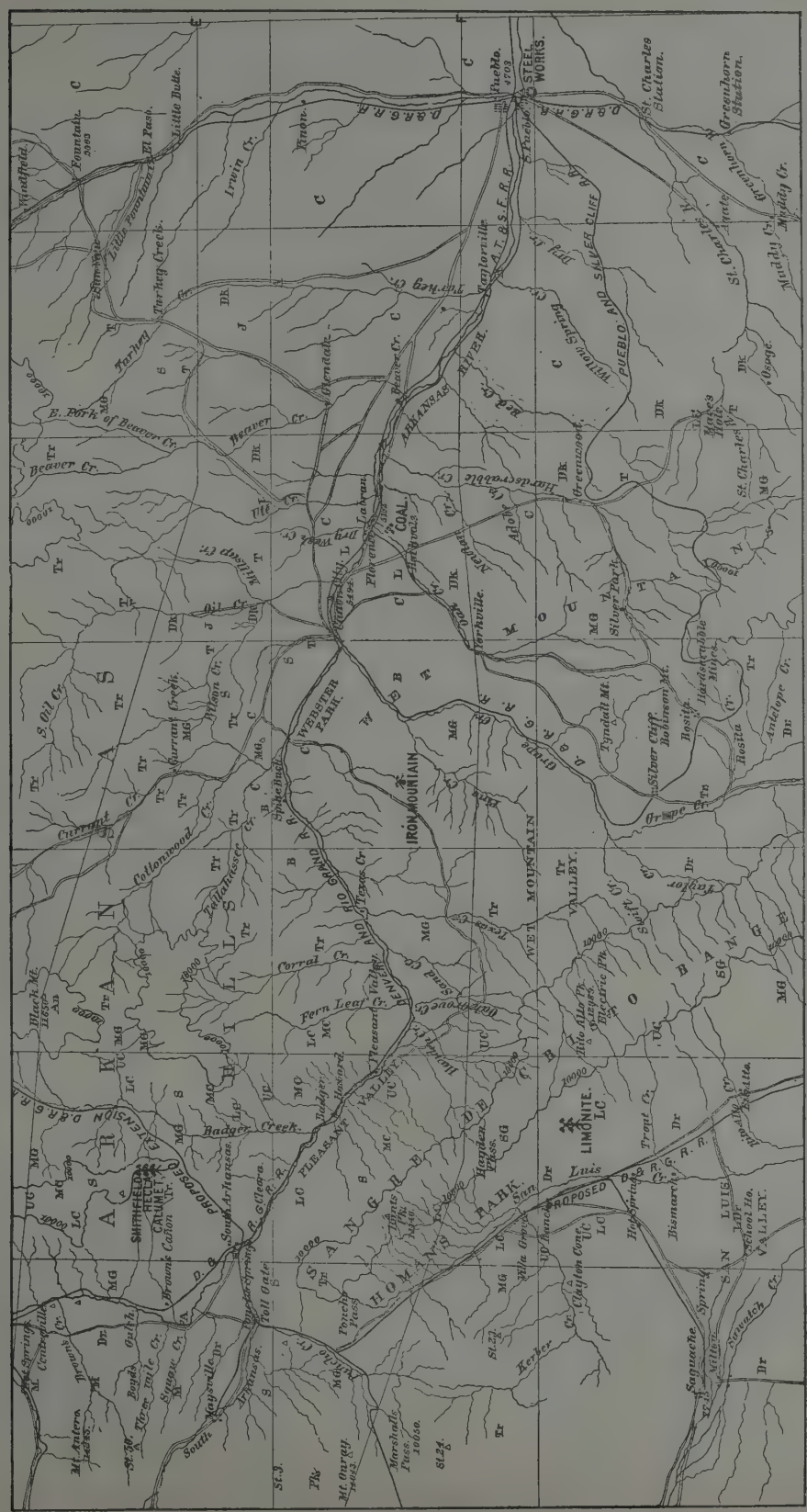


FIG. 217.—MAP OF A PORTION OF COLORADO, SHOWING THE POSITION OF SOME OF THE IRON-ORE DEPOSITS SAMPLED.

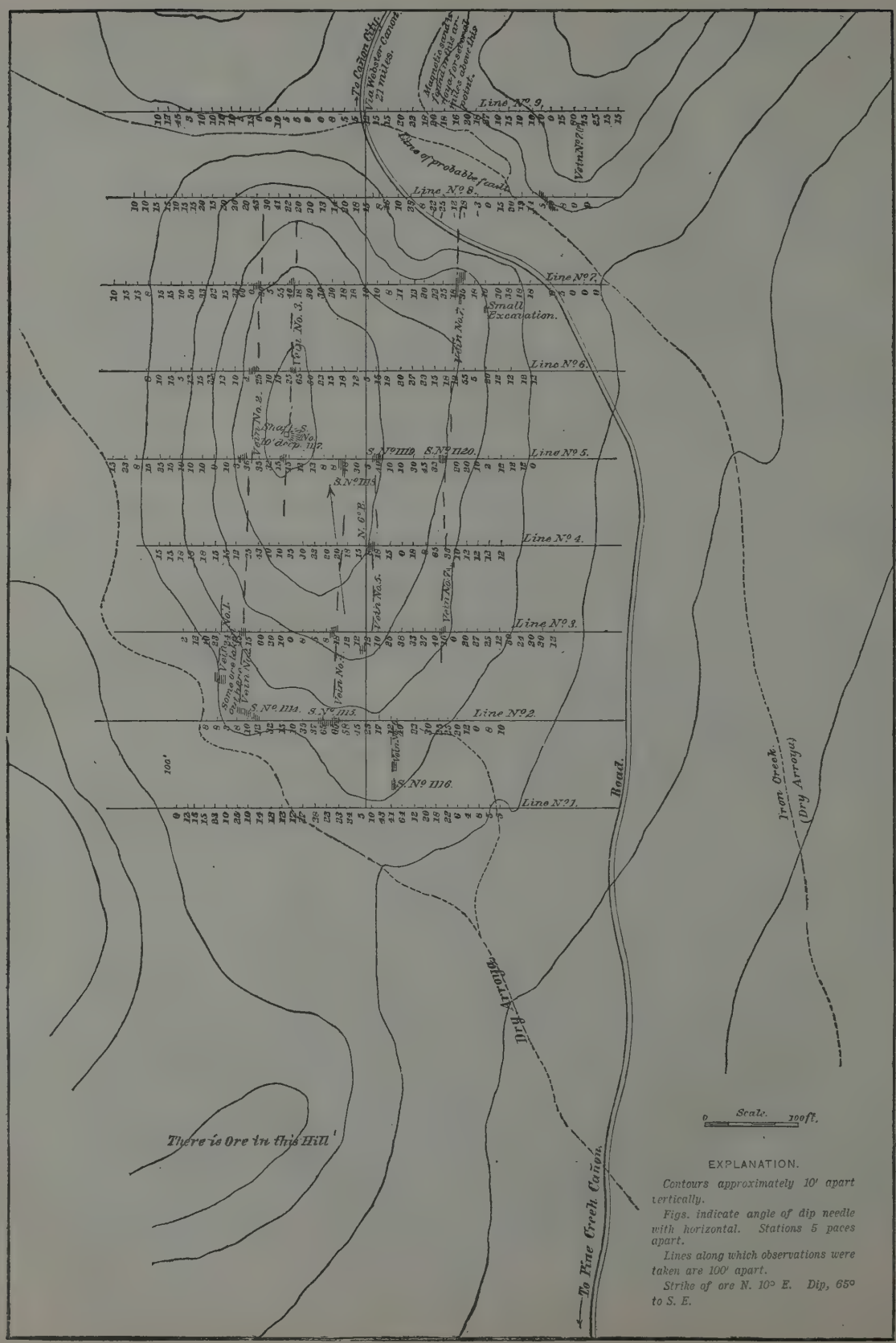


FIG. 218.—MAGNETIC MAP OF IRON MOUNTAIN, FREMONT COUNTY, COLORADO.

north 10° east, and this apparently is the strike of the ore-veins. The dip of the latter is to the southeast at a high **a** angle. The surface of the hillside and that of the valley near its foot are covered with small pieces of ore, which cause the needle to be deflected from a horizontal for some distance away from the ore-mass.

On the southwest side of the hill there is a small opening on an outcrop of a vein of ore, from which a little ore has been taken. This vein (marked No. 1) does not outcrop again to the northward, nor does the dip-needle indicate its extension in that direction, unless the dips on line No. 7 be due to it. About 20 feet east of the above opening there is an outcrop on a second vein. This seems to be the most regular and persistent if not the widest vein in the hill, excepting, perhaps, No. 7. Its outcrop can readily be traced for 600 feet or more, and near line No. 2 it is exposed for a width of 20 to 25 feet. At line No. 3 it seems to unite with the third vein. This latter outcrops on lines Nos. 5, 6, 7, and the dip-needle indicates its extension to line No. 8, though at this latter point it probably forms one with No. 2. It is possible that No. 2 and No. 3 are practically one vein, separated in places by a "horse" **b** of rock. Between No. 2 and No. 4, on line No. 2 there is a gully in which a gray granite (?) outcrops, and although this was the only rock outcrop seen, the configuration of the hill would seem to indicate that the rock extends northward through the hill, and has been more eroded than the ore-mass. Vein No. 4 is fully 50 feet wide on line No. 2, but it narrows toward the north, and the last outcrop—a small one—is seen a few feet south of line No. 5. The needle does not indicate its extension as far as line No. 6. The next vein, No. 5, first outcrops on the "base-line", a few feet south of line No. 3. Its northernmost outcrop is a little north of line No. 5. The sixth vein outcrops on line No. 1 and between it and No. 2. No outcrop was seen north of No. 2, but the vein appears to extend at least to line No. 3. The seventh vein was first discovered outcropping on line No. 3; it was traced northward to line No. 7. For some distance this vein forms the edge of the hill-top or ridge. The slope of the surface changes **c** immediately east of it. A short distance north of line No. 7 the eastern ridge of the hill terminates quite abruptly, and the vein is not traceable farther in this direction. To the northwest, on the north side of Iron creek, ore again outcrops, however, and the strike of the vein is here about the same as in the Iron hill. It appears probable, therefore, that vein No. 7 has been faulted about on the line of Iron creek, and thrown to the *right*. This supposition is strengthened by the negative attraction of the needle along line No. 8.

Whether the seven veins of ore thus traced out are all distinct and separate, is, of course, not possible to say without actual cross-cutting; but, with the exception of veins Nos. 2 and 3, such seems to be the case. The behavior of the needle might appear to indicate that magnetite is distributed in some quantities through the entire hill. It must be remembered, however, that the surface of the hill is covered with float-ore. The rock outcropping on line No. 2, both east and west of vein No. 4, contains little if any magnetite, yet the needle was deflected when held **d** immediately over this outcrop.

Excepting that the ore from the southern part of the hill is more weathered, the feldspar gangue being in some cases kaolinized, giving the mass a mottled appearance, all the ore examined is remarkably alike, considering the extent of the deposit. The ore from the small shaft on vein No. 3 is jet-black in color on weathered surface, compact in texture, shows a well-developed prismatic structure, and is very heavy. On fresh fracture it has a peculiar luster, which is perhaps best described by the word "graphitic".

I learned from the analyses of M. Chaper's samples, before visiting the locality, that part of the ore at least contained a large percentage of titanic acid. As the titanium-carrying ore cannot be hand-picked from the ore free from that element, it seemed important to determine if the latter was not concentrated in one or more bands, leaving the others comparatively free from it. Samples were therefore collected from the outcrop of each vein. These **e** samples contained—

	1114.	1115.	1116.	1117.	1118.	1119.	1120.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	48.89	48.18	46.61	48.85	46.05	47.01	47.42
Phosphorus	0.025	0.026	0.037	0.011	0.040	0.039	0.026
Titanic acid	11.99	12.92	11.61	12.73	13.84	14.86	13.04
Phosphorus in 100 parts iron	0.051	0.054	0.079	0.023	0.087	0.083	0.055

Sample 1114 is from outcrop of vein No. 2 at the southwestern side of the hill. Sample No. 1115 is from outcrop **f** of vein No. 3 on line No. 2. Sample No. 1116 is from outcrop of vein No. 6, between lines Nos. 1 and 2. Sample No. 1117 is from a small pile of ore thrown out from a test-shaft on vein No. 3, near the top of the hill north of line No. 5. Sample No. 1118 is from outcrop of vein No. 4, near line No. 5.

The analyses indicate that all this ore contains too much titanium to be used alone in the blast-furnace. The low contents in phosphorus of the different samples is noticeable, as is also the nearly uniform percentage of metallic iron. The samples consisted of series of chippings across the different outcrops.

a The following analyses of this ore were published in the report of the Colorado Improvement Company, previously referred to.

	A.	B.	C.
	Per cent.	*Per cent.*	*Per cent.*
Silica	8.60	18.60	2.75
Alumina	4.00	7.00	7.70
Lime	1.60	1.30	None.
Magnesia	2.30	1.60	3.20
Titanic acid	14.00	10.00	----------
Peroxide of iron	70.50	62.00	----------
Magnetic oxide of iron	----------	----------	67.76
Sulphuric acid	----------	----------	Trace.
Phosphoric acid	----------	----------	Trace.
Oxide of manganese	----------	----------	Trace.
Total	101.00	100.50	----------

b

Samples A and B were collected by M. Chaper, and analyzed at the School of Mines, Paris. Sample A is a c "compact titaniferous magnetite with feldspathic gangue, from Iron mountain (Grape creek), Fremont county, Colorado". Sample B, "an oxidized iron sand, forming the bed of Iron creek for several miles above Iron mountain. A portion of the iron exists in the state of protoxide, which is all converted into peroxide, whereby the increase in weight results." C is an analysis of a sample of the ore by Charles S. Hinchman, made in 1871. The titanic acid was not determined.

The iron sand represented by analysis B is a noticeable feature of the surface geology near Iron creek, above Iron mountain. It is widely distributed through the surface material, and the ant-hills, of which there are many, are in a great measure made of it. Many of the grains are too large to be properly called sand, being $\frac{1}{8}$ inch or more in diameter. Their edges are all rounded. They have evidently been derived by the alteration and erosion of a rock containing much feldspar and magnetite.

A mass of titaniferous magnetite occurs in *Caribou hill*, near the Caribou and other silver mines, in Boulder d county. Caribou is 20 miles from Boulder, near the Continental divide. Its elevation above tide is 9,900 feet. Two small openings were made at the western end of the outcrop some years since, and a little ore was taken out and teamed to Boyd's smelter at Boulder. The pits are 8 to 10 feet deep and 6 to 8 feet wide. The ore exposed in them and seen on the dump varies greatly in richness, the mass being made up of little seams of rich compact magnetite, lying in a silicious magnetic rock. The outcrop extends along the crest of the hill, and is about 400 feet in length. The north side of the hill is completely covered with float-ore. All the ore is very magnetic, and exhibits polarity to so marked a degree that the dip of the needle changes from +90° (north end down) to −50° (south end down) in the distance of ten paces. There is undoubtedly a large amount of iron-ore in the hill, but it is probable that the rich ore is too irregularly distributed through the rocks to permit of its being economically mined, even if other circumstances were favorable. Sample No. 1105 consists of selected pieces of the rich ore. Sample No. 1106 e is an average of a small pile of ore near the western opening. The samples contained—

	1105.	1106.
	Per cent.	*Per cent.*
Metallic iron	59.04	35.35
Phosphorus	0.017	0.022
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.029	0.062

On Strain creek, in the foot-hills, near Morrison, Jefferson county, a discovery of what was supposed to be a f valuable deposit of iron-ore was made in the spring of 1880. The "claim" is known as the *Jefferson County Iron mines*. The question of its ownership is now before the courts. If the locality which I visited was the right one, and I was assured by my guide that it was, the "ore" is of no value as an ore of iron. The deposit is situated about three-eighths of a mile above the mouth of Strain creek gulch, which latter is $1\frac{1}{4}$ mile south of Morrison, and consists of an amphibole schist with magnetite. Three pits have been made in this rock at the upper (western) opening. The "vein" (or seam of amphibole schist) is about 75 feet wide, but it narrows toward the east, and at the lower opening, some 500 feet distant from the upper one, it is not more than 10 feet in width where exposed at the surface. The strike is such that the schist crosses the gulch between the openings above referred to and is exposed along the north side of the creek for some distance. At the west, red granite, containing a large amount of feldspar and but little mica, lies on either side of the schist. Outside of the granite is gneiss. The granite thins out toward the

east, and at the eastern opening the schist lies wholly in the gneiss. The percentage of magnetite in the "ore" a appears to be greater at the western opening than elsewhere, and here sample No. 1107 was taken. The sample contained—

	1107.
	Per cent.
Metallic iron	20.56
Phosphorus	0.069
Phosphorus in 100 parts iron	0.336

b

In the Arkansas hills, about 9 miles from South Arkansas station (at the junction of the South Arkansas and Arkansas rivers), in Chaffee county, a vein of magnetic ore was being explored in February, 1881, by the Colorado Coal and Iron Company. The vein, striking northeasterly and dipping southeasterly, has been traced with the compass along the west slope of a mountain ridge for a distance of over 4,000 feet, and three claims have been staked on it. These are, in order from south to north, the *Calumet*, the *Hecla*, and the *Smithfield*.

The surface of this and the neighboring ridges is covered with eruptive rock (the trachorheite of Hayden's map), which masks the underlying geology. The immediate associate of the ore is a soft, whitish material composed chiefly of carbonate of lime. This contains, besides the seams of magnetite of varying widths, crystals of green epidote and quartz. c

At the Calumet mine a trench 53 feet long has been cut across the formation, exposing a band of fine-grained magnetite, 12 feet wide, lying in the above-mentioned rock. A slope has also been sunk immediately under this band of ore for a depth of 68 feet, at an angle of 46°, following the depth of the vein. Ore forms the roof of this slope from the surface down. It is the intention of the company to drive a tunnel eastward across the ore-belt at a depth of 75 feet below the surface.

At the Hecla claim only a small opening has been made into the side of the hill. It has exposed an irregular mass of ore lying in the calcareous rock.

At the Smithfield claim a shaft was sunk, but it was filled with *débris* when visited. No ore was seen on the dump, but the compass-needle was deflected near the shaft.

A sample of the ore (No. 1176) was taken at the bottom of the slope on the Calumet claim, and in the prospect d cut on the Hecla claim (No. 1176 x). These samples contained—

	No. 1176.	No. 1176 x.
	Per cent.	*Per cent.*
Metallic iron	49.23	48.03
Phosphorus	0.026	0.008
Phosphorus in 100 parts iron	0.053	0.017

Titanic acid was not determined, but it is reported to be present only in small quantities. e

Magnetite in Carboniferous(?) limestone.—The *Ainsworth* and *Stoddard* mines (so called) are situated in Costilla county, in the Sangre de Cristo mountains, on the east side of Grayback gulch, about 5 miles north of Placer (a station on the Denver and Rio Grande railroad), and 4½ miles from Veta pass. Both mines are on the Trinchera land grant, and are owned by the railroad company and others. They are leased to the Colorado Coal and Iron Company, and are now being explored by it. The discovery of iron ore at this point must have been made soon after the discovery of the placer deposits, for which Grayback gulch was at one time noted, as pebbles and small boulders of magnetite occur in considerable numbers through the sand and gravel. The tracing of these pebbles to their source in the bed of magnetic ore was easily done. In 1877 an opening was made at the Ainsworth mine, by H. T. Sefton and F. Proctor, and between 1,000 and 1,500 tons of ore are said to have been mined and shipped for flux, principally to Mather & Geist, at Pueblo. A survey for a spur-track to the mines has already been made, f which, if built, will be 4½ miles long, and will connect with the main road 2 miles east of Placer station. From this junction to the summit of Veta pass is 9 miles; beyond the latter point there is a continuous down grade. The distance from the mines to the steel-works at South Pueblo by this route will be 81 miles.

The Ainsworth opening is in the hillside, about 740 feet above Grayback creek, while the Stoddard opening, on the same side of the hill, is only 180 feet above the same point. The ore at both places is a fine-grained magnetite, carrying calcite and occasionally a crystal of pyrite, bedded in the limestone. This limestone is colored on Hayden's map as Upper Carboniferous. At the Stoddard mine active explorations were begun in August, 1880. An incline was built and a tunnel was started into the outcrop of ore along the strike of the vein (about north 80° east). After passing through 26 feet of ore, a vertical face of rock (limestone) was encountered, which was penetrated for a distance of 30 feet before the drift was abandoned. This break in the vein is due to a fault, and it seems probable

a that the rock to the east of the line of fault has been lifted to a height of over 500 feet. Under this supposition the relation of the Ainsworth and Stoddard deposits is readily accounted for, as is indicated in Fig. 219. The

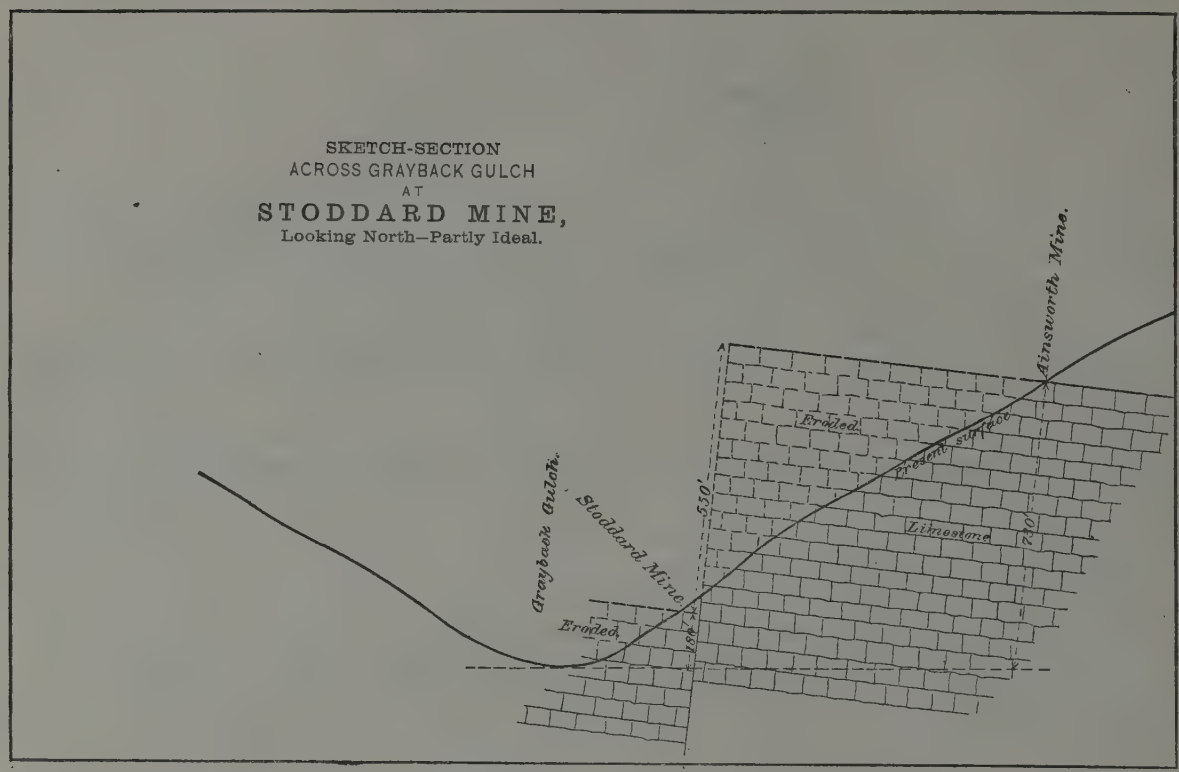


FIG. 219.

direction of the fault is at a slight angle with that of the gulch. In consequence of this, and of the dip of the vein causing the outcrop to pitch toward the south, the wedge-shaped mass of ore remaining increases in width toward the latter direction. But I understand that later explorations south of the first opening have developed the fact that the vein there becomes so thin and "pockety" as to be practically unworkable. Sufficient work had not been done at the Ainsworth mine when visited to prove the extent of the deposit. From what I could see, however, I e infer that the ore will be found to lie in pockets rather than in any well-defined regular vein.

Near the outcrop at both openings, but more especially at the Stoddard mine, the ore is largely peroxidized. The samples of the ore collected yielded, on analysis—

	No. 1108.	No. 1108*a*.	No. 1109.	No. 1110.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	59.23	47.74	55.56	52.58
Phosphorus	0.016	0.008	0.039	0.059
Phosphorus in 100 parts iron	0.027	0.017	0.070	0.112

f Sample No. 1108 is from the face of the lower drift at the Ainsworth mine. Sample No. 1108*a* is from the upper drift in the same opening. Sample No. 1109 is from a pile of weathered ore from the lower drift at the Stoddard mine. Sample No. 1110 is from a pile of 500 tons of ore at the bottom of the incline; all from the tunnel

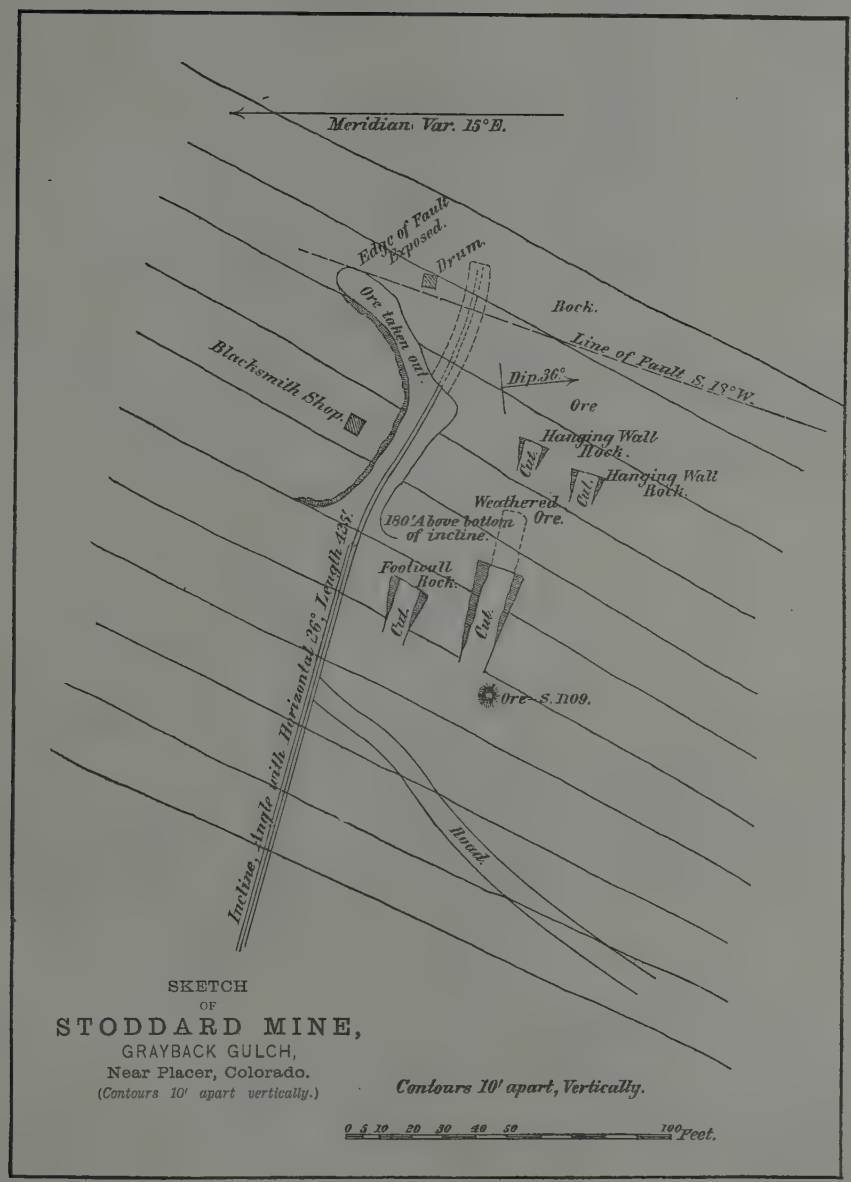

Meridian Var. 15°E.
Edge of Fault Exposed.
Drum.
Ore taken out.
Rock.
Line of Fault S. 18°W.
Blacksmith Shop.
Dip 36°
Ore
Hanging Wall Rock.
Cut.
Hanging Wall Rock.
Cut.
Weathered Ore.
180' Above bottom of incline.
Footwall Rock.
Cut.
Cut.
Ore S. 1109.
Incline Angle with Horizontal 26° Length 455'.
Road.
SKETCH
OF
STODDARD MINE,
GRAYBACK GULCH,
Near Placer, Colorado.
(Contours 10' apart vertically.)
Contours 10' apart, Vertically.
0 5 10 20 30 40 50 100 Feet.

FIG. 220.

a of the Stoddard mine. This last sample represents, therefore, a fair average of the probable shipping product of the mine. Other analyses of the Stoddard ore, kindly furnished me by the vice-president of the Colorado Coal and Iron Company, were as follows:

b

	A.	B.	C.
	Per cent.	*Per cent.*	*Per cent.*
Silica	11.90	8.60	3.53
Oxide of iron (Fe_2O_3)	82.10	81.20	.....
Alumina	3.90	2.20	1.70
Lime	0.20	2.80	0.83
Magnesia	Trace.	0.38	0.91
Phosphoric acid	0.096	0.102	.....
Manganese	.....	.....	0.11
Titanic acid	.....	.....	None.
Moisture	.....	.....	None.
Volatile matter	4.20	4.60	.....
Total	102.396	99.882	.....
Metallic iron	57.50	56.84	67.30
Phosphorus	0.04	0.045	0.007
Sulphur	.....	.....	0.03

c

Analyses A and B were made at the North Chicago rolling mill, January 24, 1880. A note on the report states that "both samples were somewhat magnetic, especially No. 1" (A). Analysis C was made by Mr. H. L. Wells, the chemist of the Colorado Coal and Iron Company. The "sample" was evidently a picked specimen.

A sample of magnetic ore was sent me by Mr. T. W. Robinson, of Fairplay, with a letter stating that it had been mined near Hamilton, Park county, and used at one time in the Holland smelter for flux. The sample was taken from a pile of about 25 tons of crushed ore at the latter place. The following is the result of its analysis:

d

	1132.
	Per cent.
Metallic iron	63.01
Phosphorus	0.040
Titanic acid	Absent.
Manganese	Present.
Phosphorus in 100 parts iron	0.053

Owing to deep snow the locality was not visited by me. At the date of Mr. Robinson's letter the Holland smelter was idle, and no work was being done at the mine.

Hematite.—Several specimens of hematite were shown to me as having come from the Arkansas hills, but the only mass of the anhydrous peroxide seen in Colorado was at the *Breece Iron* mine, near Leadville. This is a e specular ore, which in powder is largely lifted by the magnet, but in mass has little effect on the compass-needle. It resembles the hard specular ores of the Marquette region, Michigan. The mine is located on the western slope of Breece hill, overlooking Adelaide park, and is distant from Leadville, via Stray Horse gulch, about 2½ miles. Its elevation is about 1,000 feet above the railroad depot in Leadville, and 11,150 feet above tide-level (see Fig. 221).

f

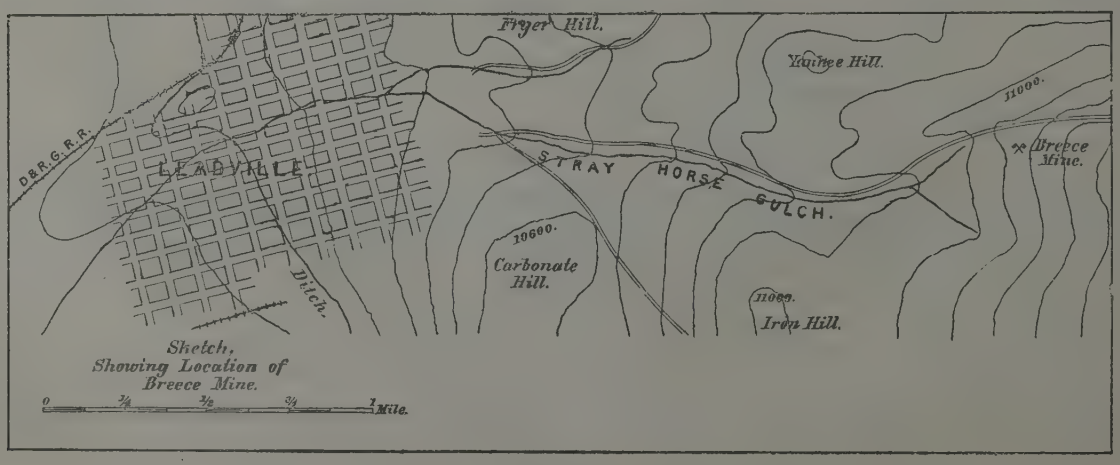


FIG. 221.

In the abstract of his report on the geology of Leadville in the *Annual Report of the United States Geological* a *Survey* for 1881, Mr. S. F. Emmons thus refers to the ore-body.

The Breece Iron mine has a remarkable deposit of red hematite, mixed with magnetite, which occurs at the contact of the main sheets of white and gray porphyry. Its ore is found at the surface in two bodies, having a maximum thickness of nearly 30 feet each, the lower of which is underlaid by white porphyry; while between it and the upper body, which is apparently an offshoot from the main body, is a sheet of decomposed porphyry which has certain resemblances both to the pyritiferous and the gray porphyry. This deposit is apparently due to the oxidation of a mass of iron pyrites which were brought to their present position in solution in a similar manner to the other ore-deposits of that region. Indications of iron are found along the contact line between the white and gray porphyry to the eastward, but as yet no considerable bodies of iron have been developed. West of the Breece mine the Superior and the Mountain Boy, on the ridge connecting Breece and Yankee hills, have also struck a considerable body of iron between gray and the white porphyries. This may be a continuation of the Breece iron body, the intermediate portion having been removed by erosion of the head of Stray Horse gulch, which has brought to the surface the white porphyry underlying the gray. On the other hand, while the Breece iron is an b anhydrous red hematite, the material developed in these shafts consists of brown hematite, limonite, and bluish-gray chert, the usual replacement material of sedimentary beds. Moreover in the neighboring shaft of the Theresa mine, shales belonging to the Weber series have been found in the same relative position, for which reason the outcrop is indicated on the map by the color of that formation.

On page 43 of Hayden's report for 1873, this deposit of ore is mentioned, and it is there stated that a similar ore-mass, presumably a part of the same vein, was observed in Iowa gulch, 6 miles south of Stray Horse gulch.

The Breece mine has been worked fer some years to supply the Leadville smelters with flux, but during the past summer the demand for the ore has fallen off, owing to the discovery that the second-grade silver ores from the Amie mine would give good results in the furnace, and possessed the advantage of containing a few ounces of silver to the ton. The mine was idle at the date of my visit, November 15, 1880. The sketch (Fig. 222) indicates c

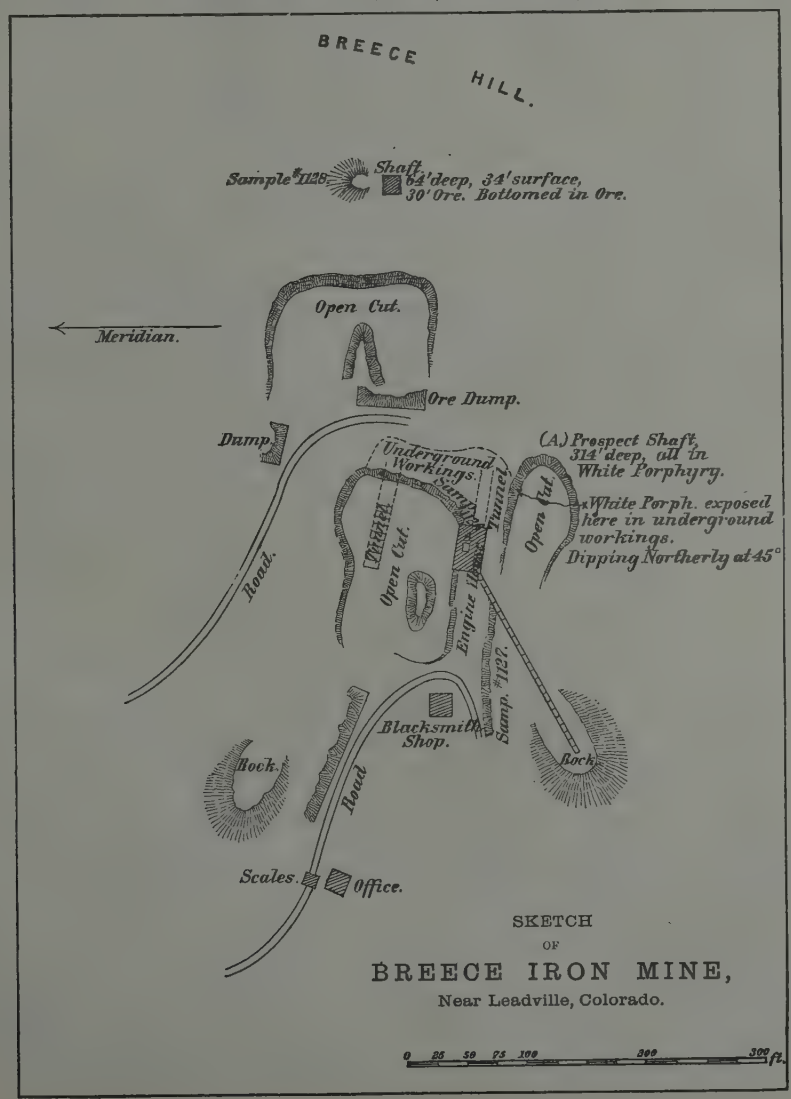


FIG. 222.

a the extent of the developments at that time. It also shows the location of the samples, which were found to contain—

	1126.	1127.	1128.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	64.35	61.51	63.25
Phosphorus	0.917	0.038	0.024
Phosphorous in 100 parts iron	0.026	0.062	0.038

b Sample No. 1126 is from a pillar between two stopes in the underground workings in the lower ore-body. Sample No. 1127 is from a pile of about 100 tons on the dock near the south slope. Sample No. 1128 is from a pile of ore thrown from a new shaft east of the upper cut. This shaft is 64 feet deep, and the lower 30 feet of it are in ore, in which it is bottomed. This ore-body seems to be a portion of the upper bed.

Copies of the following analyses of Breece ore were furnished by Colonel Lamborn:

c

	A.	B.
	Per cent.	*Per cent.*
Oxide of iron	.....	98.57
Silica	1.605	0.60
Titanium	None.	None.
Sulphur	.....	0.247
Phosphorus	0.008	None.
Manganese and lime	Traces.	None.
Loss	.....	0.583
	.....	100.00
Metallic iron	66.299	69.00

Analysis A was made by Booth, Garrett & Blair December 10, 1879. Analysis B was made at the United
d States assay office, New York, February 1, 1880.

Limonite.—Although containing too much lead and silver to be in a commercial sense an ore of iron, samples were taken from the low-grade ore of the *Amie* mine. This mine is situated on Fryer hill, near the Little Pittsburgh and Chrysolite mines, and is the first mine about Leadville that has been able to sell its low-grade ore. This ore appears to be much less silicious than the low-grade ores of the neighboring mines, and makes, I am told, a very good flux. It is reported to carry from 10 to 30 ounces of silver to the ton.

During the summer the owners of the Amie mine have sold all the old dumps, and they are now raising 75 tons of low-grade ore a day. The ore seen was partly brown in color and partly dark blue or black. The former is known as "red" and the latter as "black" ore. The red ore is probably a mixture of the hydrous and anhydrous
e oxides; the color of the black ore seems to be due to manganese. The samples contained—

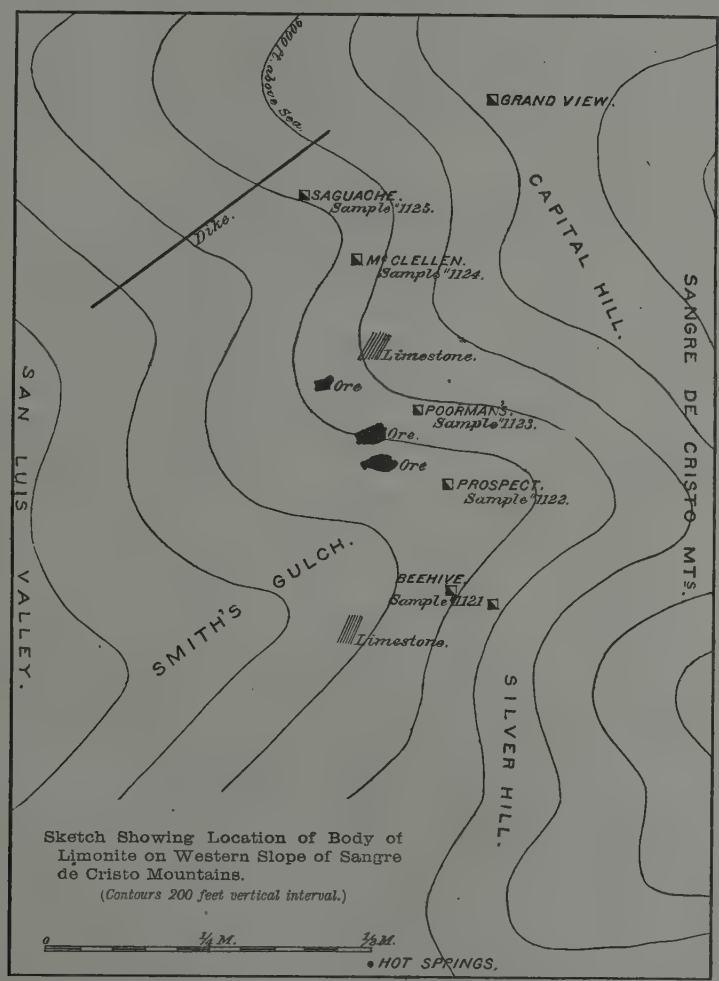
	1129.	1130.	1131.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	40.95	50.20	44.38
Phosphorus	0.058	0.076	0.049
Phosphorus in 100 parts iron	0.142	0.151	0.110

Manganese and lead are present in, and titanic acid is absent from, all the above samples.

Sample No. 1129 consists of selected chippings of the black ore. Sample No. 1130 of selected chippings of the
f red ore. Sample No. 1131 is from a pile of 500 tons of ore at the Grant smelter. The latter represents a fair average of the "run of the mine".

Perhaps the most remarkable body of iron ore seen by me in Colorado is a deposit of limonite situated in the western foot-hills of the Sangre de Cristo mountains, overlooking the San Luis valley, about 5 miles south of the western end of Hayden's pass. It was noted by Mr. Endlich in 1873 (Hayden's *Report*, etc., 1873, p. 333), but I believe has nowhere been described. The largest outcrop is in what is locally known as Smith's gulch, 8 miles southeasterly from Villa Grove, and 4 miles northwesterly from the now abandoned post-office of Bismarck. From Poncho Springs, the present terminus of the Gunnison extension of the Denver and Rio Grande railroad, the distance to this deposit via Poncho pass, is 30 miles; and it is 25 miles from the point where the railroad, on its way to Marshall pass, will leave Poncho Creek gulch. This, then, is the distance to the nearest point on any railroad in process of construction. On Neil's map of Colorado a "proposed" railroad is laid down, running over Poncho pass through Villa Grove and Saguache to Alamosa. Such a road would pass within 6 or 7 miles of the ore.

One mile south of the ore-deposit are a number of hot springs, which furnish sufficient water to wash several hundred tons of ore a day, should washing be found desirable. The largest outcrop of the ore is on the north side of the gulch. It is over 100 feet in width, and from a distance it resembles more a mass of magnetite than one of limonite, for its surface is jet black in color, due probably to the presence of manganese. The ore lies in a blue limestone, apparently within the area colored on Hayden's map as Lower Carboniferous. Higher up on the mountain side a white, highly silicious, slaty limestone or calcareous quartzite, containing dendritic manganese, was observed. A great deal of exploring has been done on both sides of Smith's gulch in search of silver-bearing copper ore. At the contact of the iron ore and the limestone there is sometimes a narrow seam of copper-bearing minerals—copper pyrite, copper carbonates, and gray copper. Generally, however, this band is represented simply by a green streak. Assays of the copper ore show only from 8 to 20 ounces of silver to the ton; and thus far not more than a few hundred pounds of this "mineral" have been mined. But it has been with the hope of striking a rich vein that a number of shafts have been sunk and tunnels driven, which now serve to prove the extent of the deposit of iron ore. The relative position of the claims referred to is shown on the accompanying sketch (Fig. 223). There are



Sketch Showing Location of Body of Limonite on Western Slope of Sangre de Cristo Mountains.
(Contours 200 feet vertical interval.)

FIG. 223.

two shafts on the Beehive claim on the south side of the gulch. The more easterly of these is nearly 100 feet in depth, and is near the eastern side of the body of iron ore, at the contact of the latter with the limestone. One side of the shaft is limestone; the other three sides are principally yellow and red ochers. Very little good iron ore was seen on the dump. At the western opening a shaft has recently been started from the end of a tunnel, which penetrates the hillside to a distance of 70 feet. The bottom of the shaft is now 20 feet below the tunnel level, and its sides are all good iron ore. On the dump there are many tons of an excellent looking cavernous limonite, which could be used in the furnace without washing. Sample No. 1121 was taken from the dump. On

a the north side of the gulch, east of the outcrop above mentioned, a shaft 74 feet deep has been sunk on the Prospect claim. This shaft is apparently all in iron ore, as the dump shows no rock. The ore in the dump is represented by sample No. 1122. A little gully, filled with surface *débris*, lies between the Prospect shaft and the outcrop of ore.

The *Poorman's* shaft is a small prospect pit situated some 500 feet north of the Prospect, higher up on the side of the mountain spur. A portion of the ore seen here contains considerable red ocher. Sample No. 1123 consists of selected chippings from those lumps of ore which were comparatively free from this substance.

The *McClellan* lode is located in a "wash" north of Smith's gulch. Here a tunnel 40 feet long has been driven into the hillside, the first 25 feet through limestone, the last 15 feet in ore. The end of the tunnel is ore. A slope b of about 50 feet in length has also been sunk along the contact of the limestone and ore (which has an easterly dip of 55°), and a cross-cut begun from the bottom of this slope. The slope is sunk partly in limestone, so that the dump contains a large amount of rock, but the ore exposed along the sides of the tunnel is rich and of good quality. Its principal gangue seems to be carbonate of lime, which often occurs crystallized. Sample No. 1124 consists of a series of chippings taken along the sides of the tunnel, and is believed to represent a fair average of this part of the ore-body.

The *Saguache* claim is northwest of the McClellan. The shaft was filled with snow, but the size of the dump indicates that it is not deep. Part of the ore thrown out from the shaft is a compact red hematite, and contains considerable baryte. A dike-like ridge cuts across the mountain spur north of this claim, which probably explains c the occurrence at this point of anhydrous ore. Sample No. 1125 was taken from a few lumps of ore on the dump near the above shaft.

At a small opening on the Grand View claim, northeast of the McClellan tunnel, and about 10,000 feet above tide-water, there is a small seam of comparatively compact limonite, 1 foot thick, with a strike nearly at right angles with the line of the chief outcrops. Both walls are limestone.

The *Beehive* shaft is over 3,000 feet from the Saguache shaft. How much good ore there is between these two openings now covered with surface *débris* can only be determined by exploration. As a rule limonite occurs in pockets of no very great depth, and there is no evidence to indicate that this rule does not hold in this case. At the same time it is, I think, safe to say that there are here many thousands of tons of ore "in sight". This lies in such a position that it can be cheaply mined, and although it may be desirable to wash a portion of the ore to d separate the ocher, the greater part can probably be used in the furnace as it comes from the ground. Gottlieb Swaltzreade is the owner of the Beehive claim, the Saguache Mining Company of the Prospect and Saguache claims, and the Milwaukee Mining Company of the McClellan claim. The first mentioned was the only one upon which work was being done at the time of my visit.

The following are the analyses of the samples mentioned above:

	1121.	1122.	1123.	1124.	1125.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	54.47	55 56	51.64	55.61	45.39
Phosphorus	0.026	0.658	0.055	0.034	0.045
Phosphorus in 100 parts iron	0.048	0.104	0.106	0.061	0.099

e

Manganese is present in and titanic acid is absent from all of these samples. Large tabular masses of barite occur in the specimen from the Beehive mine (sample 1121).

Carbonate ore and its derivatives.—In connection with the coal-bearing strata of Colorado there often occurs a bed of carbonate of iron, which, through loss of carbonic acid and absorption of oxygen, changes into limonite on exposure to the ordinary atmospheric influences. The fresh carbonate, associated with silica, alumina, etc., is found usually in nodular concretions or "kidneys" in the shales and sandstones. These hard concretions have resisted disintegration more successfully than the material inclosing them, and are found to-day covering the surface of the plains (probably often to some depth) in the neighborhood of the coal strata. Reference has already f been made to the occurrence of this ore near Marshall, Boulder county, where a small furnace was built to work it. Near Walsenburg many tons were seen during a short drive. At Trinidad a small seam was observed a few feet above the coal of the El Moro mine, and at Cañon City the ore also exists in some quantity. The nodular pieces are, as heretofore found, however, too widely distributed, and the seams of the ore are too small to be of much economic importance. The unaltered ore is, moreover, quite lean. The character of the ore as regards iron and phosphorus is shown by the following analyses:

	1104.	1111.	1112.	1113.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	47.89	51.46	27.71	15.63
Phosphorus	0.305	0.047	1.190	0.556
Phosphorus in 100 parts iron	0.637	0.091	4.258	3.557

Sample No. 1104 was collected near the Marshall coal mine, Boulder county. Sample No. 1111 is from near a the El Moro coal mine. Samples 1112 and 1113 are from near Walsenburg. No. 1112 represents the oxidized coating of a nodule of ore, and No. 1113 the unaltered kernel.

IRON ORE IN WYOMING.

Magnetite.—Iron mountain, near the headwaters of the Chugwater creek, about 40 miles northwest of Cheyenne, 20 miles northeast of Laramie City, is thus described by Mr. Arnold Hague: (*a*)

Iron mountain, to which reference has already been made, is a mass of titaniferous magnetite or ilmenite, and is situated just north of the Chugwater creek, about 1½ mile above the point where the stream leaves the hills. The mountain rises about 600 feet above the stream-bed, is irregular in form, but has a somewhat oval-shaped outline. It occurs intercalated in granite, standing nearly vertical, b with the walls in places sharply defined. This is the case in the cañon, where the dark iron body resembles a broad dike, which rises to the top of the cañon wall. Frequently large masses of granite are nearly incased in the iron, and again the iron body puts out into the surrounding granite. The main deposit of iron is nearly a quarter of a mile in length, with a strike a little to the west of north and east of south. To the north the main deposit terminates somewhat abruptly, but southward it crosses the cañon and may be traced cropping out through the granitoid rocks, with the same general strike for nearly 2 miles in the direction of Pebble creek. These outcrops vary much in size, mostly mere narrow seams and small irregular patches of iron which disappear in the surrounding granite. Still farther south, just above Horse creek, considerable deposits again make their appearance, but much smaller than Iron mountain, and, like the latter, have been held for valuable mineral bodies; they are probably only a continuation of the larger one. The ilmenite occurs chiefly as a compact, massive deposit, iron black in color, with a submetallic luster. It is frequently found, however, with a coarse, granular structure. It is accompanied by small amounts of magnetite and hematite, which decompose, and give portions of the mass a brownish red appearance. Prof. O. D. Allen, of Yale College, examined specimens of the Iron Mountain ore, and found it to contain a mixture of c ferrous and ferric oxides, which gave 50.83 per cent. of metallic iron combined with 22.32 per cent of titanic acid. Other samples of the ore, analyzed by Professor Richards, of the Institute of Technology in Boston, gave the following results:

	Per cent.
Ferrous oxide	24.55
Ferric oxide	48.97
Titanic acid	23.18
Sulphur	0.03
Residue insoluble in acid	2.15
Total	98.88
Metallic iron	53.33

d

Samples of the coarse, granular variety, collected from the deposits south of Iron mountain, yielded Mr. R. W. Woodward the following:

	Per cent.
Metallic ron	34.29
Titanic acid	49.47

e

All the samples examined gave a very high, although a varying, amount of titanic acid. This high percentage of so refractory a substance as titanic acid renders the vast deposit of iron of but little use for practical purposes in iron smelting, which is to be regretted, as the beds in the Laramie hills could be easily mined, and are so well located in reference to a market, and the known sources of iron in Wyoming are so limited.

The titanic-iron deposits of Canada and Norway would appear to possess very much the same characters, with equally varying amounts of titanic acid in their composition. An analysis of a specimen from Krageröe, in Norway (*Dana, Min.*, 1868, p. 143), gave as high as 46.92 per cent. in titanic acid, and Dr. T. Sterry Hunt (*Geological Survey of Canada*, 1863, p. 501) found 48.60 per cent. from similarly situated beds at Bay Saint Paul, Canada. The ilmenite from château Richer gave titanic acid 39.86 per cent. This occurrence of ilmenite and gabbro so intimately associated together in the Laurentian rocks in widely separated parts of the globe, each with the same physical habits, and in the case of the gabbros of Wyoming and Norway, with the same minute microscopical structure and peculiarities, is most remarkable, and the causes evidently deep-seated.

Hematite.—Two and one-half miles north of Rawlins station there is a deposit of soft, reddish hematite in the f red sandstone, which, according to Mr. Emmons (*Geol. Expl. 40th Par.*, Vol. II, p. 161), underlies the lower limestone bed (Carboniferous), and is probably "in the lower Palæzoic series of the Laramie hills".

Two mines were opened here in 1871, and were worked until 1877. It is said that over 17,000 tons of ore were shipped from one of these openings, and, judging from the size of the pits, nearly the same amount was taken from the other. The ore was all used by the Utah smelters for flux. Since 1877 a few tons have been dug each year for paint, but no regular mining has been done. The two openings, known from the names of their respective owners as the *Shaw* and the *Friend* mines, are about 500 feet apart. When visited the pits were partly filled with snow and ice, and but little idea could be obtained as to the form of the deposit. The ore seen, however, appears

a Geological Exploration, 40th Parallel, Vol. II, p. 14 *et seq.*

a to be in more or less irregular pockets in the sandstone, and it seems probable that the pockets opened upon are practically exhausted. There is no very sharp line of separation between the ore and the sandstone, and I am told that the last ore shipped to Utah was very silicious. Specimens of the ore from each opening contained—

	1133.	1134.
	Per cent.	*Per cent.*
Metallic iron	56.96	63.29
Phosphorus	0.046	0.593
Phosphorus in 100 parts iron	0.081	0.937

b Carbonate ore of the coal strata, and limonite derived therefrom, is found at Evanston and elsewhere in the territory.

IRON ORE IN DAKOTA.

In his report on the *Geology of the Black Hills of Dakota*, p. 57, Mr. Newton refers to the occurrence of hematite as follows:

In several localities the silicious slates (Archæan) contain, interlaminated with them, immense quantities of iron, almost always specular oxide. On Box Elder creek a ridge some 400 feet in height is composed of a vast deposit of silicious hematite, which was estimated to be from 800 to 1,000 feet in thickness across the upturned strata. Occasionally, bands of almost pure specular hematite several inches in thickness are found in the mass, with frequent layers of highly crystallized micaceous hematite. The body of the c ferriferous strata, however, is highly siliciferous, and entirely useless as an iron ore, consisting of thin strata, an inch or less in thickness, of specular hematite, alternating with silicious slates or with pure white quartz in seams or irregular masses, the whole presenting a remarkable resemblance to the silicious banded hematite of the Huronian of the Lake Superior region. In other localities on the same creek hematites were also found, but nowhere of any practical value, because of their highly silicious character.

Mr. Jenney, on page 295 of the same volume, reports that—

Blue-block iron ore (siderite), weathering to limonite, was found of good quality in the black clay shales of the Cretaceous on Beaver creek. The deposit covered quite an area, and consisted of three horizontal layers, respectively, 8 inches, 3 inches, and 5 inches thick, separated by a few feet of clay shales. The ore closely resembles the block ores of the coal measures of Kentucky and Pennsylvania, which are worked in the small charcoal iron furnaces scattered through the timbered districts.

d

IRON ORES IN UTAH.

In the extent of its iron-ore deposits Utah may be considered the most favored region west of the 100th meridian.

Probably the largest masses of iron ore in the whole west are located in the western part of Iron county, about 225 miles a trifle west of south of Salt Lake city. The ore occurs in a subordinate ridge of the Wahsatch mountains known as the Iron mountains. This ridge is separated from the main range by Rush Lake valley, and overlooks the Escalante valley on the west. Attaining its greatest height in the rim of the Great basin at the south, the Iron mountains break gradually down toward the northeast into a series of rounded hills. The general direction of the range is northeast and southwest.

The ore deposits are in two distinct groups, *i. e.*, the Iron Springs group and the Iron City (or Oak Springs) group. The former is the most northerly. It is about 8 miles between the most southerly outcrop in the Iron e Springs group and the most northerly one in the Iron City group, but it is possible that future explorations may discover ore in this apparently barren belt. There is also iron ore in one of the two hills called the Desert mounds, which rise directly from the desert, a couple of miles west of the main ridge of the Iron mountains and 5 miles from Iron Springs.

The Iron Springs group.—Iron springs is 10 miles north of west from Cedar City, a Mormon settlement on the stage route from Milford (the present terminus of the Utah Southern railroad) and Silver Reef, and is distant 60 miles from the former and 36 miles from the latter place. At the springs the mountain ridge is cut in two by a broad transverse valley, which subdivides the group of deposits into two groups. On the north of this valley the following claims have been entered: Marshall, War Eagle, Great Western, Lost Horse, Othello, Desdemona, Atkins, Western Extension of Atkins, McGary, Norvell, Lillian, Sundown, Cumberland, and Martin. The three f first named are nearest the springs, and are by far the largest of the group. The northernmost claim is about 2 miles from the Great Western, and the others are at various intermediate points.

Of the three large outcrops, the *Marshall* is the farthest eastward. The ore forms the crest of a hill, 75 to 100 feet in height, and outcrops for 300 feet in a north 55° east direction. The dip is at a high angle, probably toward the southeast. The vein is about 50 feet wide at the middle of the outcrop, but it narrows slightly toward either end. The ore is very magnetic, and deflects the compass needle strongly, and yet attempts made to trace it from the outcrop in the direction of the strike with the dip-compass were unsuccessful. This seemed to me so curious that observations were repeated at various points, but always with negative results. It would appear from this that the ore-masses outcrop their full length and terminate quite abruptly. The different iron deposits seem to be entirely isolated from each other. The ore is compactly crystalline, often porous, and contains little scales of brown mica, and occasionally bunches or groups of minute octahedral crystals of magnetite. Sample No. 1141 consists of a series of chippings across the outcrop.

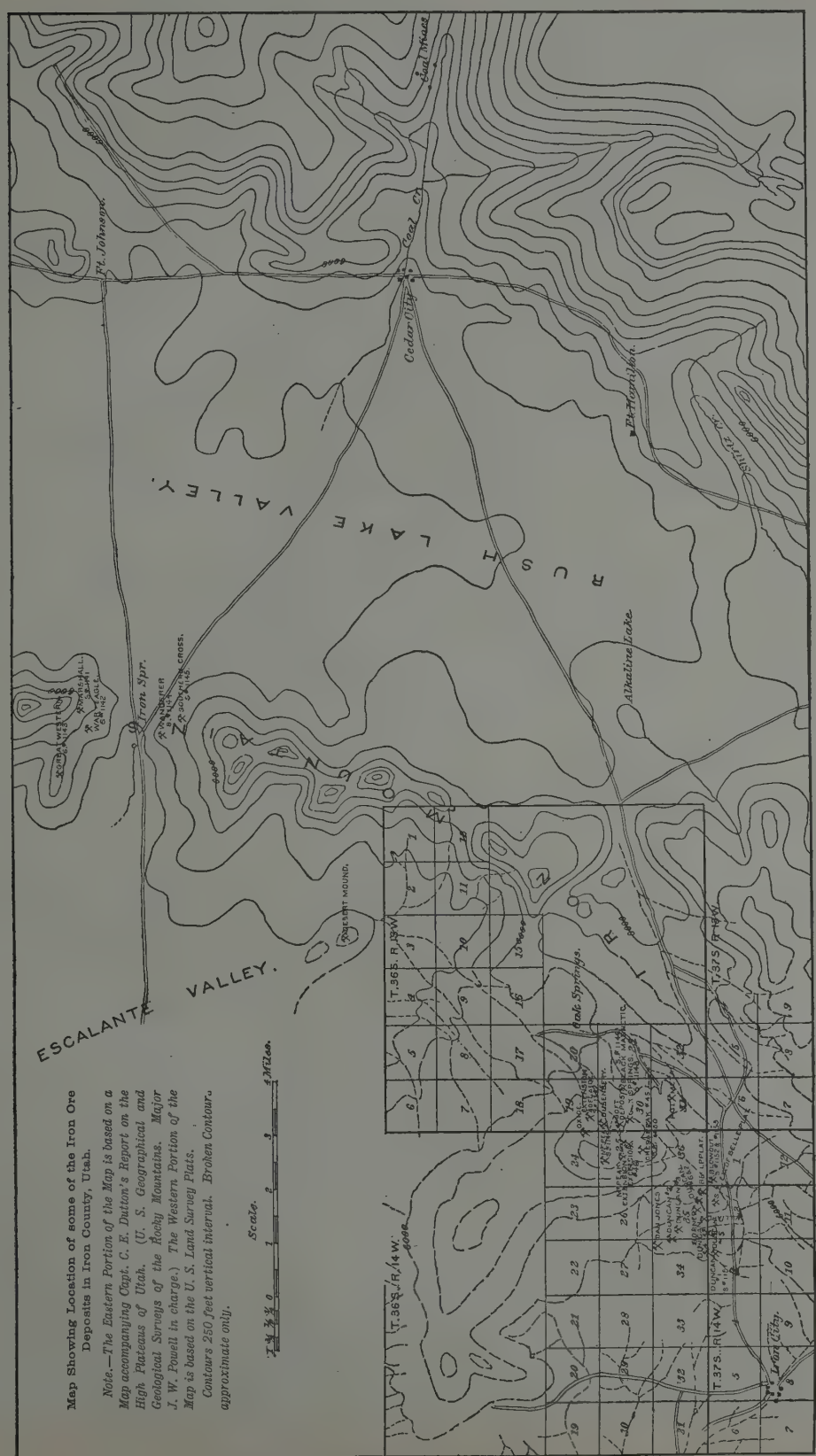

Map Showing Location of some of the Iron Ore Deposits in Iron County, Utah.
Note.—The Eastern Portion of the Map is based on a Map accompanying Capt. C. E. Dutton's Report on the High Plateaus of Utah. (U. S. Geographical and Geological Surveys of the Rocky Mountains. Major J. W. Powell in charge.) The Western Portion of the Map is based on the U. S. Land Survey Plats.
Contours 250 feet vertical interval. Broken Contours approximate only.
Scale.
4 Miles.
ESCALANTE VALLEY.
RUSH LAKE VALLEY.
Ft. Johnson.
Iron Spr.
Cedar City
Coal Ck.
Coal Mines
Ft. Harrison
Alkaline Lake
Frolic Springs
Lost Cities
T.36S. R.13W.
T.36S. R.14W.
T.37S. R.14W.
T.37S. R.13W.

Fig. 224.

a The *War Eagle* (sample No. 1142) is about 750 feet west of the Marshall. It also forms the crest of the hill. The outcrop is perhaps 300 feet long by 150 to 200 feet wide, and in shape is approximately oval. The direction of the longer axis is about north 35° or 40° east. The height of the hill is about 100 feet. Blue limestone covers the south side of the hill, and outcrops within 20 or 30 feet of the ore. The north side of the hill is covered with trachyte(?). The ore resembles that from the Marshall claim. The specimen sent in is, however, more porous, and suggests at once a metamorphosed limonite. Groups of magnetite crystals occur in many of the cavities.

The *Great Western* (sample No. 1143) is about a quarter of a mile from the War Eagle, in a direction a trifle north of west. The ore outcrops along the crest of a trachyte (?) covered hill, about 200 feet high. At the top of the hill the rock is hard and solid, but around the base, and especially on the northeast side, it is much decomposed.
b A drift enters the hill at one point for 50 feet, entirely in this decomposed, kaolin-like material. There are four parallel outcrops on the hill. The largest of these is 750 feet long and 12 feet wide. The inclosing rock has been eroded on either side, and the top of the outcrop is, at some points, 25 feet above the surface. This immense ridge or "comb" contains at least 20,000 tons of ore. It dips at an angle of 75° to the north (the strike is nearly east and west), and the south side of the hill is completely covered with boulders of ore of all sizes. I should estimate the ore above ground on this hill at between 25,000 and 30,000 tons. The other three veins are shorter and smaller in every way; still they undoubtedly contain a large amount of ore. The character of the ore is as remarkable as the deposit itself. There are numerous seams or cracks parallel with the strike of the ore, the sides of which are completely covered with crystals of magnetite. These crystals are chiefly octahedra, and vary in size from less
c than one-sixteenth to three-quarters of an inch in length. I found several clusters of rhombic-dodecahedra, but this form was comparatively rare, although the octahedral crystals were often modified with dodecahedral faces. Narrow crystals of apatite, almost white in color, and sometimes 2 or 3 inches in length, occur through portions of the ore.

On the mountains south of the springs the following claims have been located: Wanderer (sample No. 1144), Southern Cross (sample No. 1145), Pioche, Little Mormon, Vermilion, Eclipse, Prince, Lindsay, Game Cock, and Little Allie. The first two named overlook the springs, and are said to be the largest of the group. They contain an immense quantity of ore, as each deposit forms an essential portion of the mountain spur in which it lies. The ore is, as a whole, leaner than that north of the springs. The gangue is chiefly white quartz. Apatite occurs in considerable quantities. The general appearance of the ore is the same as that from the War Eagle and Marshall
d outcrops, excepting that a portion of it, especially at the Southern Cross claim, is partly peroxidized. It is, however, strongly magnetic. Several of this group of claims are on so-called "soft deposits". The Vermilion is so named on account of the color of the ore and the earth near it.

The Desert mounds were not visited.

The accompanying map (Fig. 224) shows the position of all the claims in the Iron City group. Of these the following were visited and sampled:

The *Black Magnetic* (sample No. 1146) includes two parallel veins of ore near Oak springs. The ore is of good quality and contains but little gangue.

The *Adelaide* (sample No. 1147), one of the so-called "soft deposits", is situated a half mile northwest of the Black Magnetic. It seems to form the principal portion of a low hill. A drift enters the hill 25 or 30 feet, and is
e all in ore. The ore is quite soft (in the drift it can be picked down readily). It gives a yellow to dark brown powder, which is largely taken up by the magnet, and in mass the ore deflects the compass-needle.

The *Oak Springs* claim (sample No. 1148) is on a vein of magnetic ore which outcrops on a mountain spur in a general northeasterly and southwesterly direction. Much of the ore is largely mixed with white quartz, but there is a large quantity of rich ore in the deposit. The ore is remarkable for its magnetic energy, furnishing excellent specimens of lodestone.

The *Mountain Peak* vein (sample No. 1149) outcrops along a shoulder of Mountain peak to its summit. It is 8 to 10 feet thick, very regular, strikes N. 6° W., and has been traced for 800 or 1,000 feet. It is too inaccessible to be of any immediate value.

The *Excelsior* and *Chesapeake* veins (sample No. 1150) are on the southern slope of Mountain peak. The last
f named is about 10 feet thick, and outcrops for several hundred feet, the ore in many places standing 12 or 15 feet above the surface. It is very free from gangue. The ores represented by samples Nos. 1146, 1148, 1149, 1150 are very much alike in general appearance. The magnetite is, as a rule, very compactly crystalline.

Blowout mountain, or the Big Blowout, as it is sometimes called, southwest of Mountain peak, is generally spoken of as being the largest mass of ore in Utah. It is an isolated hill or butte, 600 or 700 feet long, 350 to 400 feet wide, and about 200 feet high. It is 21 miles from Cedar city and 5 miles from Iron city, near the road between the two places. Trachyte(?) outcrops on the northern and limestone on the southern slope of the hill, but its main mass appears to be magnetic ore. Portions of the ore-mass contain considerable quartz, but there is here, apparently, an immense quantity of rich, pure ore, capable of being mined by the simplest operations, and located very conveniently for transportation. A railroad could be built directly to the hill, and the cars could be run into an open quarry, in which there would be a breast of ore over 100 feet high and possibly 250 to 300 wide. Occurring at many points on the hill, but especially near the top, are masses of ore, with a concretionary and

radiated structure similar to limonite, which show, as suggested by Dr. Newberry, the sedimentary origin of the a ore-body. Sample No. 1153 consists of numerous chippings of this variety of ore. Sample No. 1152 consists of a series of chippings taken at uniform intervals across 150 feet of the outcrop, where the ore is freest from quartz intermixture. It represents a fair average of a large portion of the ore-mass.

West of Blowout mountain there are several so-called "soft deposits", the largest of which, known as *Duncan No.* 1, is located a few rods north of the Iron City road. The southern part of the hill is limestone (which also covers the valley to the south). The top of the hill is mainly a lean, partially-weathered, although quite hard, magnetite. Two drifts have been driven into the hillside above the limestone, one 50 feet and one 25 feet in length. The former passes through 15 feet of soil and 35 feet of soft ore; the latter through the same amount of surface material and 10 to 12 feet of ore. The ends of both drifts are ore. The ore resembles that of the Adelaide (sample No. 1147). The powder is nearly all lifted with the magnet. Sample No. 1151 was taken along the sides of the b drifts. The samples contained—

	1141.	1142.	1143.	1144.	1145.	1146.	1147.	1148.	1149.	1150.	1151.	1152.	1153.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*
Metallic iron	57.55	61.43	67.81	64.09	61.64	67.09	63.21	65.48	67.09	68.06	59.41	67.31	68.44
Phosphorus	0.248	0.198	0.113	0.264	0.425	0.080	0.182	0.064	0.093	0.059	0.066	0.057	0.038
Phosphorus in 100 parts iron	0.431	0.312	0.167	0.412	0.689	0.119	0.288	0.098	0.139	0.087	0.111	0.085	0.055

Two analyses of the ore from this region by Captain C. E. Dutton, of the Ordnance Corps, U. S. A., were c published in Vol. III of Lieutenant Wheeler's *Report on Explorations and Surveys West of the* 100*th Meridian.* They are as follows:

	Red hematite ore.	Magnetic ore.
	Per cent.	*Per cent.*
Insoluble residue (silica and silicates)	3.34	3.81
Magnetic oxide of iron (Fe_3O_4)	5.64	67.68
Peroxide of iron (Fe_2O_3)	82.97	28.00
Water	6.06	0.10
Alumina	1.35	0.38
Manganese	.....	Trace.
Sulphur	0.06	None detected.
Phosphoric acid	0.19	None detected.
Lime	0.33	.....
Total	99.94	99.97
Metallic iron	62.16	68.61

d

As to the age of these deposits nothing definite is known, and the solution of the problem will necessarily be greatly complicated by the overflows of eruptives, which cover the sedimentary rocks near almost all of the outcrops. e Limestone occurs in the lower valleys, and at Iron springs sandstone and conglomerate were observed, apparently overlying the limestone.

Professor Newberry visited this locality in 1879, and in a paper on the "Genesis of Our Iron Ores" (*School of Mines Quarterly*, November, 1880) he briefly describes them. He says: "As to the age of this remarkable series of iron-ore deposits I cannot speak with absolute certainty, though they are apparently Lower Silurian."

In the Wah-Wah mountains in Beaver county, 35 or 40 miles west of north from Iron springs, magnetite oxidized at the outcrop to limonite has been mined, and teamed to Frisco for flux. Samples of the ore were collected at the Horn Silver smelter at Frisco. Sample No. 1135 is from a pile of 25 tons of ore from *Bowen's* mine, a small opening on the east slope of the Wah-Wah mountains, about 22 miles southwest from Frisco and 15 miles northeast of Sulphur springs. The ore sampled was all peroxidized. Sample No. 1136 was also taken f at the Horn Silver smelter, from 15 tons of ore, from *Money's* mine, on the ridge of the Wah-Wah mountains, 6 miles west of Bowen's mine and about 20 miles from Frisco. The ore is a mixture of the per- and magnetic oxides.

The samples contained:

	1135.	1136.
	Per cent.	*Per cent.*
Metallic iron	60.63	57.84
Phosphorus	0.012	0.015
Phosphorus in 100 parts iron	0.020	0.026

a A deposit of hematite, probable the croppings of a vein of magnetite, has recently been opened upon on the west side of the Frisco mountains, about 6 miles from Frisco. The ore will be teamed to the lead smelters.

In the Star mining district, in the Picacho mountains, between Frisco and Milford, there are several deposits of iron-ore. The *Vulcan* mine, on the east side of the range, about 7 miles from Milford, has sent some ore to Frisco. The ore is a limonite, and is reported to carry a small amount of silver. Sample No. 1137, from a few tons at the smelter, represents this ore. The analysis shows it to be fairly rich in iron, but it is said to make a poor flux, and but little of it has been used in the furnace. A portion of the pile was certainly very silicious.

The *Lake Superior* mine, at the north end of the district, about 7 miles from Milford and 3 miles from the railroad between Milford and Frisco, was entered for copper by Forgie Brothers, of Frisco. The claim includes an b irregular deposit of magnetic ore, 80 feet wide at one place, with an outcrop 500 feet long, lying between quartzite and granite. The strike of the ore is northeast and southwest. Toward the southwest it can be traced up a little ravine, between a spur of granite on the northwest and one of quartzite on the southeast, but within 500 feet of the widest part of the ore-belt outcrops of granite and quartzite were observed, only a few feet apart. On the side of this ravine two shafts have been sunk, in search of copper ore, to depths of about 60 feet each. The dumps near these shafts consisted of quartzite stained with iron oxide and copper carbonate. In some specimens a little copper oxide could be seen. In a prospect shaft 150 to 200 feet northeast of the widest part of the ore outcrop a lean magnetite ore was seen; but a short distance beyond this, and in the line of the strike, there are several outcrops of granite and quartzite. The ore contains a great deal of carbonate of lime, and the average of the vein would probably not yield over 30 per cent. of metallic iron, but there are numerous little seams, a few c inches in width, which will run perhaps 60 per cent. in iron. Sample No. 1140 represents the better quality of the ore. It consists of numerous chippings from different parts of the outcrop. The high percentage of phosphorus is a noticeable feature. No apatite was noted in the ore.

The Rocky mining district is about 3 miles northeast of the north end of the Star district, in the same general range of hills, which latter are, however, cut by a broad transverse valley between the two districts. The railroad from Milford to Frisco passes through this valley. In the southern end of the Rocky district, 4 miles from Milford, and about 1 mile from the railroad, many claims have been located on supposed copper veins, and some magnetic ore has been mined and teamed to Frisco. The largest opening on the iron ore is on the eastern slope of a spur of the hills overlooking the Beaver river; and was worked by the Frisco Mining and Smelting Company. The d excavation is partly open cut and partly underground, but is not more than 15 or 20 feet deep. The body of ore is very irregular and different parts of it appear to vary greatly in richness. The mine has been idle for some months; a sample of the ore (No. 1139) was collected at the Frisco smelter. The rock in the immediate vicinity of the mine is quartzite; granite outcrops a few rods to the east, lower down the hillside. A few hundred feet west of the opening there is an outcrop on a vein of ore, which from its direction appears to be an extension of the Lake Superior belt in the Star district. This vein also is very irregular, and much of the ore is too lean to be valuable.

In the Bradshaw mining district, in the Mineral range of mountains, an argentiferous limonite occurs. From the *Cave* mine in this district, 7 miles southeast of Milford, worked by the Frisco Mining and Smelting Company, an ore is obtained which is said to average $20 75 in gold and silver to the ton. Sample No. 1138 is from a pile of 20 tons of this ore at the smelter.

e The above-mentioned samples contained:

	1137.	1140.	1139.	1138.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	49.61	57.25	62.23	39.31
Phosphorus	0.139	0.237	0.014	0.044
Phosphorus in 100 parts iron	0.280	0.414	0.022	0.112

The East Tintic mining district, in the dividing ridge between Goshen and East Tintic valleys, contains important deposits of limonite, which have been worked for several years past to supply the lead smelters at Sandy f with flux. The mines are situated on both sides of the divide. Those on the east of the ridge are about 16 miles west of Santaquin. Much of the surface of Goshen valley is only a few feet above Utah lake, and the bottom lands, over which the road to the mines passes, are sometimes flooded and often very muddy. This mud is largely adobe, so that the teaming is at times very heavy and difficult. A railroad could probably be built around the southern rim of the old Utah lake basin quite easily, and I understand such a road has been talked about. The ore occurs in irregular deposits at the contact of limestone and a much decomposed rock locally known as "porphyry". The explorations of the Fortieth Parallel did not extend so far south as this, and I believe the district has never been studied geologically.

The Oquirrh mountains, of which the Tintic mountains are a southern extension, are, however, mainly composed (according to the Fortieth Parallel maps) of Carboniferous rocks, and it is not improbable that the limestone found in contact with the ore is of Carboniferous age.

The conditions surrounding the ore-deposits resemble in many particulars those at the Breece mine, near a Leadville. The mines are chiefly worked in open cut, but a few of the larger ones are now partly underground. No timbering is used in any of the openings and no machinery. In many cases the carts can be backed directly to the face of the ore; where this is not possible the ore is wheeled in barrows to the dump. The openings are all in the hillside, and generally some distance above the bottom of the gulch, so that all surface-water drains off naturally and no pumps are required.

The following is a list of the mines, with their respective owners:

Name of mine.	Location.	Owner.	Operator.	No. of men employed.
East of divide.				
Black Stallion	Black Stallion gulch	Oliver Durant	Henry Dieterle	12
Red Chief	do	Henry Dieterle	do	6
Billings	do	John Snell	Thomas Clayson	3
Red Stallion	Burriston gulch	Henry Dieterle and Riter	Henry Dieterle	2
Hematite	do	William Fall	William Fall	3
Sailor Boy	do	Henry Dieterle	Henry Dieterle	3
Queen of the West	do	do	do	3
Iron Queen	Black Stallion gulch	A. Peryon	A. Peryon	6
Mountain Chief	do	A. Noon	A. Noon	3
Raven	Noon's hollow	do	do	3
Double Cave	do	do	do	3
Vulture	do	do	do	6
West of divide.				
Le Bonde	Ruby hollow	Henry Dieterle and Riter	Henry Dieterle	2
Southern Extension Dragon	Dragon's hill	W. Huntington	do	12
Iron Clad	do	A. Peryon and Green	Peryon and Green	2
Reverse	do	Green	Green	2
Eliza	do	do	do	2
Total				61

The Black Stallion was opened in 1873 or 1874; the Billings in 1874; the Iron Queen and the Mountain Chief d in 1875. West of the divide, the Le Bonde was opened in 1873; the Southern Extension of the Dragon late in 1877. All the other mines have been opened since 1878. The Dragon mine proper is a silver mine. No patents have thus far been obtained. The claims are held by assessment work only, and as there is no machinery, there has been practically no investment either in property or in plant.

The peculiarity of most of the ore is its dark color, due probably to the presence of manganese. The Black Stallion ore (sample No. 1155) is especially noticeable in this respect, but the ore from nearly all the mines is dark, and much of it is almost black. The ore in the stopes is quite soft, and is picked down readily. With the exception of pockets of white and gray clay, the ore-mass is quite free from gangue matter. The walls, however, are so irregular that mining to any great depth will be expensive on timber account. The mines west of the divide were idle at the date of my visit, as there was too much snow in the mountains to permit teaming the ore across them; e but a sample (No. 1160) was taken from 50 tons of ore from the Southern Extension of the Dragon, piled near the stage-station. The samples collected from this district contained—

	1155.	1156.	1157.	1158.	1159.	1160.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	52.47	48.21	61.18	51.40	46.46	59.30
Phosphorus	0.043	0.096	0.142	0.420	0.052	0.259
Phosphorus in 100 parts iron	0.082	0.199	0.232	0.817	0.112	0.437

Sample 1155 is from 30 tons of *Black Stallion* ore; color of ore blue-black, of powder dark brown. Sample f No. 1156 is from face of stope and from small pile of broken ore in *Hematite* mine; color of ore reddish brown, of powder dark brown. Sample No. 1157, from broken ore and face of stope in *Sailor Boy* mine; color of ore almost blue-black, of powder dark brown. Sample No. 1158, from face of stope in *Queen of the West* mine; color of ore reddish-brown, of powder yellowish-brown. Sample No. 1159, from 50 tons of ore from *Billings* mine; color of ore blue-black, of powder dark brown. Sample No. 1160, from 50 tons of ore from *Southern Extension of the Dragon* mine; color of ore blue-black, of powder brown.

The variation in the percentage of phosphorus is great. With the exception of No. 1160, the samples were collected from mines all within an area of an eighth of a mile radius. It may be noted that the Queen of the West (sample No. 1158) is a small opening, so that the sample is taken almost from the outcrop.

At Ogden I was told that there were numerous deposits of excellent iron ore in the Wahsatch mountains,

a within a radius of 10 or 12 miles of the city. Ogden cañon was said to be especially rich in this ore, and several so-called iron mines were visited, but I did not see anything which seemed to me of importance. Several localities on the mountains I was unable to go to, however, on account of deep snow.

The *Vulcan* mine is on the south side of Ogden cañon, about 2½ miles from the city of Ogden. It is a mere prospect pit on a quartz seam impregnated with oxide of iron (sample No. 1161). A few specimens of a silicious hematite were seen in the dump, but I saw nothing to indicate the presence of a workable body of ore. Two or three claims have been located on this same quartz seam, which appears to extend along the side of the cañon for some distance.

On the east side of Cold creek, a tributary to Ogden river, about 7 miles from Ogden city, there is a layer of b red ferruginous rock lying between quartzite (Ogden?) and slate, which it has been supposed was a valuable iron ore. I am told that some of this "ore" was used in the Ogden blast furnace. The vein is thin; at no point where it has been opened upon is it more than 6 inches in width, and the ore is seen from the analysis (1162) of selected chippings to be worthless as an ore of iron.

On the western side of Willard peak, overlooking Great Salt lake, and about 2¾ miles from the town of Willard, a station on the Utah and Northern railroad, 14 miles from Ogden, is a deposit of micaceous specular ore. It is owned by J. M. Barker, and Harden Brothers, of Willard, and was opened in 1870, and between that date and 1873 some 7,000 tons of ore were mined, and about 5,000 tons were shipped to the lead smelters for flux. The remaining 2,000 tons are stocked at the foot of the mountain, back of Mr. Barker's house, 1¼ mile from Willard c station. Since 1873 assessment work only has been done at the mine. The mine was not visited owing to snow, but the ore is said to lie between slaty limestone and quartzite; it is probably therefore in the Cambrian. The ore in the pile was very silicious, and the quartz material was so thoroughly intermixed with the ore that it would be difficult to "cob" it successfully. Sample No. 1163 is better than the average of the pile, and yet it contains only about 50 per cent. of metallic iron.

The three samples last mentioned contained—

d

	1161.	1162.	1163.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	45.94	9.89	51.31
Phosphorus	0.026	0.130	0.038
Phosphorus in 100 parts iron	0.057	1.315	0.074

IRON ORES IN MONTANA AND IDAHO.

As mentioned in a foot note on p. 472, neither Montana nor Idaho were visited in the winter of 1880–'81, and no definite information regarding the iron ore resources of that region were then obtained. Since then the work of the Northern Transcontinental Survey has proved the existence of numerous, and in some instances, important iron-ore deposits. A deposit at Cable mountain, Deer Lodge county, Montana, and one on East Boulder creek, Gallatin e county, are referred to in the note.

IRON ORE IN NEVADA.

I learned very little about iron ore in Nevada, but it is not improbable that it exists, and in workable quantities, at many points in the state.

On pages 585 and 586 of Vol. II, *Geological Explorations Fortieth Parallel*, Mr. S. F. Emmons describes a body of ore near the line of the Central Pacific railroad as follows:

In the neighborhood of Palisade cañon, the andesite core of the range has been overflowed and mostly concealed by a flow of trachyte, which in its turn is covered by extensive flows of rhyolite, which mask the greater portion of the range north of the river. * * * Apparently inclosed in this trachyte, on the south bank of the river, at the mouth of a little side-cañon, is a hill a few hundred feet in height, containing a large mass of iron ore, remarkably fine-grained, and having a thoroughly conchoidal fracture. At a little distance it might be mistaken for a basaltic rock. An analysis of this ore, made by Mr. B. E. Brewster, gave the following results:

f

	Per cent.
Ferric oxide	84.217
Alumina	0.178
Manganous oxide	1.454
Magnesia	0.472
Water	1.713
Insoluble residue	12.518
Total	100.552

Which would give a percentage of metallic iron 58.95. The occurrence of such a body of iron ore in the midst of volcanic rocks is an interesting phenomenon, though it is probably too far from any source of fuel-supply to be of practical value. It is, however, a remarkably pure ore, being entirely free from phosphorus or sulphur, though containing a rather high percentage of silica.

At Humboldt station Mr. C. S. Wright, the proprietor of the Humboldt house, gave me a large specimen of a magnetic ore, which he told me was found in the Jackson mountains, about 40 miles northwest of Humboldt, where "a vein of ore 15 feet wide can be traced for several thousand feet". Chippings from the specimen contained—

	1164.
	Per cent.
Metallic iron	66.75
Phosphorus	0.320
Phosphorus in 100 parts iron	0.479

The ore is a massive magnetite, free from pyrite, but containing numerous long, whitish crystals of apatite. b

IRON ORE IN CALIFORNIA.

In Blake's *Report of a Geological Reconnaissance in California* (New York, 1858), in Whitney's *Report of the Geological Survey of California*, Vol. I (1865), in J. Ross Browne's *Report on the Mineral Resources of the States and Territories West of the Rocky Mountains* (Washington, 1868), and in several of the volumes of Raymond's *Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains*, mention is made of the occurrence of iron ore at a number of localities in the state of California. A list of these will be given hereafter. With the exception of the deposits of chromic iron ore, valuable for its chromium, there appear to be, however, but two groups of deposits which have thus far attracted much attention as a probable source of iron. One of these lies c in the foot-hills of the Sierra Nevada, in Placer county, the other higher up in the mountains, partly in Sierra and partly in Plumas county.

The latter is owned by the Sierra Iron Company, and was reported on by Baron F. von Richthofen in 1865, and by Clarence King and James D. Hague, conjointly, in 1873. Von Richthofen's report was published in pamphlet form at Virginia City, Nevada, November, 1865. Messrs. King and Hague's report has, I believe, never appeared in print in entirety, but a long abstract was published in Raymond's report for 1874, pp. 44 *et seq.* Von Richthofen described the geographical and geological position of the deposits and the character of the ore as follows:

Locality.—California, though rich in many other metals, has heretofore proven poor as to the occurrence of the ores of iron. The rumor of the discovery of valuable deposits in 1864–'65 in the higher parts of Sierra county appeared, therefore, to offer a subject worthy d of exact examination. During repeated visits to these places from May to October, 1865, I have found that the deposits, so far as explored till then, are situated on the headwaters of the North and Middle forks of the North Yuba river, about 12 miles east-northeast of the city of Downieville, and a few miles north of the culminating rocky summits of the Sierra buttes. The country is mountainous; its waters escape to the west through ravines. Near their sources these ravines expand to basins and valleys, often filled by lakes and separated from each other by ridges of little elevation above their level. Communication, therefore, is comparatively easy between the different parts of these highlands, as well as with the adjacent eastern valleys, such as Mohawk valley and Sierra valley, which again are connected by excellent roads with the state of Nevada. The iron deposits are situated near the high parts of these mountains, along a line of about 2 miles in length, which connects some of the above-mentioned basins, its southerly end starting from Gold valley, on the Middle fork, while its northerly end extends to a depression on the headwaters of the North fork, and the central part runs through a gap between both forks. Gold valley is a fine basin with good meadows on the bottom-lands and timber on the surrounding hillsides. Its altitude is from 6,000 to 6,200 feet above the level of the sea, while the iron-ore deposits at the northern extremity of the line may have an elevation of 6,500 feet. The timber extends far above this altitude. Winter in these mountains is severe, but will not interrupt e smelting-works if sufficient supplies of ore and fuel are provided.

Geological formation.—The deposits of iron-ore occur along a line bearing about NNW.-SSE. in an equally directed belt of a certain class of metamorphic rocks, which is bounded east by granite and west by metamorphic slate, and extends over 4 miles in width, by several times this amount in length. It consists of hard rocks, distinguished by their silicious and often ferruginous character, the constant presence of hornblende and chlorite as ingredient parts, a great variety of stratification, which frequently is missing. It is well known as one of the richest gold-bearing belts in California, the veins being among the widest and most continuous which are worked to profit, and containing the precious metal remarkably equally dispersed, while the slate to the west and the granite to the east contain generally but poor or barren veins of quartz. Some gold-bearing veins are being worked profitably close to the deposits of iron ore.

Parallel to the western boundary line of this belt, and a little distant from it, runs a series of small bluffs of yellow crystalline limestone, bounded on both sides by chlorite slate. The iron ore accompanies this limestone in the shape of abrupt deposits of varying extent. Neither the limestone nor the iron ore forms a continuous band, but either of them occurs in apparently disconnected bodies along one and the same well-defined line. It therefore happens that the iron ore in places is connected with the lime, while at others it f is imbedded in and forms part of the chlorite slate. The shape of these deposits is what is called in German "Erzstock".

Character of the ore.—These mines can boast of the best quality of iron ore which is known to exist. They consist altogether of magnetic ore, the same from which the celebrated Swedish and Russian iron is manufactured. Practically, this ore occurs at your mines in three different conditions:

First, massive magnetic iron ore of remarkable purity. It is very fine-grained, and reminds one of the appearance of steel. Its yield in iron is from 60 to 65 per cent.

Second, a mixture of pure magnetic ore with carbonate of lime. The latter is in a state of calcspar, or marble, and fills cavities in the former. If not present in too large quantity, it rather improves the ore by serving as a flux. Different bodies present different gradations of the combination of the two substances, from pure magnetic iron to limestone, with an admixture of the same, the proportion of iron being occasionally as low as one-fifth in bulk and one-third in weight. Such quantities, by being added to the others, will form an eminently good flux. The ores of this second class may in general be considered as rich as those of the first class, as the latter have necessarily to be mixed with the only impurity of the former in order to be prepared for smelting.

a Third, chloritic and talcose slate, containing innumerable crystals of magnetic iron, the relative bulk of which to that of the other mineral substances varies from 3 : 1 to ½ : 1, and less. The impurities are the same which are frequently combined with magnetic iron, principally the silicates of alumina, magnesia, and protoxide of iron. As magnesia is present in the form of silicates (varieties of hornblende, especially asbestos and some talc), it will not be injurious to smelting. None of those substances which, by the smallest admixture, deteriorate the quality of iron, such as phosphorus or sulphur, appear to be present. The yield of iron of those ores of this third class, which form the bulk of the deposits, will not be short of 50 per cent.

Mr. King and Mr. Hague thus refer to the mode of recurrence of the ore, its probable quantity, and its quality:

Mode of occurrence.—From the northernmost outcrop in Spencer's ravine the iron deposits appear as an irregular detached chain of bodies, trending south-southeast across the Four Hill valley and reappearing over a low divide on approximating the same line, a mile farther south, in Gold valley.

Following as they do the strike of the inclosing rocks, it is most probable that these isolated outcrops represent a single zone of b lenticular deposits of ore, and that those portions visible above ground are but a small portion of the whole mass. While it is not to be expected that there is anything like a continuous vein of ore along the whole length of the line, yet it is fair and reasonable to expect greater quantities under the surface than appear above it. Accompanying the bodies throughout their entire occurrence is a stratum of limestone, standing nearly vertical, and representing a variety of metamorphic stages, from a compact gray form to highly crystallized, marbleized varieties, and extensive masses of calcspar. The iron deposits appear as bold bluffs, vein-like outcrops, and broad, dome-like bodies, as will be more particularly described below.

Four Hill group comprises eight or ten different outcrops. Of these the northern, and perhaps the most important, is a bold knob about 40 feet in height and 40 in diameter, rising from the northern slope to the ravine. It is comparatively a solid mass of remarkably pure magnetic oxide of iron, having a fine grain, like the texture of steel. Along its western side it is curiously intermixed with calcspar, which mineral occurs freely in the neighborhood. From this one outcrop alone may be quarried several thousand tons. Southward, on the line indicated, throughout a distance of half a mile, occur similar, though smaller, outcrops, having the form of large branches, except on the southern end and near the Gold Valley divide, where the outcrops are more linear and vein-like. At this end also the ore is more c highly oxidized, approaching hematite in composition. From the topography of the Four Hill region, which is generally a rough, rapidly-rising flank of Spencer's ravine, there are good facilities for getting the ore down to the ravine bottom, where a road or tramway will afford connection with the proposed site of the works. By simply quarrying the surface-ore it is estimated that twenty or twenty-five thousand tons may be made available, and this without making any allowance for the downward continuation of the bodies, nor for those masses exploration is sure to develop.

The Gold Valley deposits first appear nearly or quite a mile distant from the Four Hill deposits, but preserving about the same general direction. The main body in this series lies near the bottom of the valley, presenting a smooth, glacier-worn, and rounded surface, standing out prominently above the inclosing rock and soil. The superficial area of this outcrop is hardly less than 60,000 square feet, and the slope of the surface and its projection above the contiguous soil indicate a thickness of, say, 40 feet. This would give about 300,000 tons as the quantity of ore available in this bed alone for quarrying. About 500 feet farther south a similar but smaller outcrop appears, and there is a probability that the two are connected beneath the surface.

Quantity.—We think it safe to say that the aggregate amount of ore in sight in the Gold Valley and Four Hill deposits is not less than d 350,000 tons. This estimate is based on surface measurements of the outcrops, and on such assumed average thickness or depth for each outcrop as its projection or elevation above its inclosing rock would fairly indicate, not taking into account any probable continuation of the ore in depth or any connected deposits extending beneath the surface-soil and concealed from view. It is quite probable that a much larger quantity than the amount named will be found, since it is not likely that the whole of this deposit is exposed to view. Baron von Richthofen, the eminent geologist, who carefully examined this deposit several years ago, estimated 1,400,000 tons as the probable quantity available for quarrying, and although we do not place the amount "in sight" at more than 350,000 or 400,000, we still think it quite probable that his estimate will be fully confirmed and exceeded by actual development.

Quality.—These deposits consist chiefly of magnetic iron ore of excellent quality. In some bodies of the Four Hill group the ore is almost pure magnetic oxide, presenting when freshly broken a clean, shiny, iron-black fracture, free from any impurity, and containing about 70 per cent. of metallic iron. Other portions of these deposits contain the magnetic ore mixed with calcspar and dolomite, the intermingled mineral being desirable as a flux; this character of ore although containing less per cent. of metallic iron, say 50 per cent., is more valuable for smelting than the first. The mass of the deposits in Gold valley contains more silicious ore which carries from 40 to e 60 per cent. of iron.

The following is from an analysis made by Professor H. Schrother, of Vienna, to whom a specimen of the Gold Valley ore was sent for examination. He reports the quantitative determinations as follows:

f

	Per cent.
Protoxide of iron	*26.40
Peroxide of iron	*57.40
Silicic acid	15.87
Carbonate of lime and loss	0.33
Total	100.00

* Equal to 60.687 metallic iron.

We have also caused examinations to be made by Professor Thomas Price of specimens of ore from the various deposits. He reports that he finds nothing practically deleterious in the composition of the ore. Tests made for sulphur, phosphorus, and titanium show only the most minute traces, too slight to be practically considered, while the per cent. of iron in the poorest selected specimen was 34 (34.70) per cent., and in the better pieces 41, 55, and 70. He regards the ores as of excellent quality, and capable of being mixed to great advantage for smelting purposes. It is probable that the average yield of all the ores, when mixed for smelting, will be not less than 40 per cent. of metallic iron.

The deposits of ore in Placer county, to which reference has already been made, consist both of magnetite and of limonite. The body of magnetite is located on Sec. 15, T. 13 N., R. 8 E., 4 miles from Clipper Gap station and 7 miles from Auburn. Like that in Sierra county this deposit occurs in the metamorphic (auriferous?) slate

series, associated with limestone. Its outcrop is, however, small, and the developments had not, at the date of a my visit, progressed far enough to prove the size of the ore-body. The vein appears to extend in an east and west direction along the north side of a low ridge, and to dip at a high angle towards the south. A cut has been driven into the hillside through the gravel and decomposed rock which forms the hanging-wall of the ore, thus exposing a face of the latter. The vein has not been cross-cut, but a small trench through the surface-soil apparently at a right angle with the strike, has uncovered a width of 36 feet of ore. A pile of about 30 tons of ore from the cut is on the bank. It is represented by sample No. 1170. The California Company, the owners of the ore-deposit, began building a 40-ton furnace in the spring of 1880, a few hundred feet north of the above opening. West of this ridge is a small valley, where limestone outcrops at several points, and beyond this is another low ridge in which there is an outcrop of magnetite. A short cut has been made into the hillside also, and a few tons of ore taken out. Sample b No. 1171 came from this opening. The strike of the vein is nearly east and west, but the outcrop is southwest of the one near the furnace, so that this is either on a distinct vein or the one vein has been faulted along the valley between the ridges. The distance from one opening to the other is about a quarter of a mile.

Limonite exists at several localities within a radius of 2 or 3 miles of the furnace. The most important deposit thus far opened upon is situated in Sec. 24, T. 13 N., R. 8 E., about 2 miles from the furnace. It is owned by the California Iron Company, and is probably the deposit referred to on page 284, of Vol. I, *Geological Survey of California* (Whitney). The ore lies along the west side of a ridge, and a number of openings have been made into the hill, cutting the ore-body. The largest of these is about 50 feet long, and exposes a breast of ore 10 or 12 feet high. Two drifts, one 6 and the other 12 feet in length, enter the ore-body at right angles with its c strike without crossing it. A pile estimated to contain 350 tons of ore was on the bank. Sample No. 1172 represents an average of this pile. The above-mentioned samples contained—

	1170.	1171.	1172.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	67.68	64.98	53.41
Phosphorus	0.068	0.047	0.178
Phosphorus in 100 parts iron	0.100	0.072	0.333

The magnetite represented by samples Nos. 1170 and 1171 is partially weathered and contains no pyrite. The d analyses proved it to be a rich ore, and probably sufficiently pure to be used for the manufacture of Bessemer steel. For this latter purpose, however, the limonite is not adapted. Analyses of specimens of ores from this region were made by Mr. Hauk, the state mineralogist, with results as follows:

	Magnetite.	Limonite.
	Per cent.	*Per cent.*
Silica	3.23	33.10
Sesquioxide of iron	80.05	55.25
Protoxide of iron	17.06	.....
Lime	.....	1.65
Sulphur	.....	Trace.
Phosphorus	.....	Trace.
Water, hygroscopic	.....	2.90
Water, combined	.....	6.45
Total	100.34	99.35
Metallic iron	69.29	38.68

e

The specimen of limonite analyzed by Mr. Hauk probably did not come from the same deposit as my sample No. 1172. The percentage of water shows the ore to be a mixture of the hydrous and anhydrous oxides.

A deposit of hematite has long been known to exist 3½ miles westwardly from Saint Helena, Napa county, f in portions of Secs. 3, 4, and 9, all in T. 7 N., R. 6 W., and several hundred tons of ore have been mined at different times for use as flux. In the spring of 1880 a few tons were mined for use in an experimental petroleum furnace. A few pounds of iron were made, but the experiment was not a success. The property belongs to Edson Adams, esq., of San Francisco. The ore lies in various sized pockets, in a band of red jasper, which appears to be a local variety of the metamorphic rock of this region. Five or six openings have been made in the hillside on as many pockets of ore, but these proved to be small, and were soon exhausted. Near the ore-bodies the jasper is often covered with a thin scale of specular hematite, which gives to a lump of it, when viewed in one direction, the appearance of being a solid piece of excellent ore. Many little seams of specular ore (a sixteenth of an inch or less in thickness) were seen penetrating the quartz-mass, evidently filling previously formed cracks. While it is possible that there is altogether a considerable quantity of ore in the hill, the pockety and irregular form of the deposit is such that it appears doubtful whether it can be mined economically. A large amount of dead

a work, in removing inclosing rock, etc., would necessarily have to be done, and the uncertainty of finding new pockets when the old ones were exhausted would probably make mining operations hazardous. All the openings were filled with *débris* washed in from the sides of the pits, so that only a little ore was seen in place. A few specimens were taken for analysis from a couple of sacks of the ore in Mr. Adams's office. These contained—

	1173.
	Per cent.
Metallic iron	47.45
Phosphorus	1.870
Phosphorus in 100 parts iron	3.940

b

Other analyses of selected specimens of the ore gave results as follows:

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ferric oxide	90.05	89.85	80.50	87.79
Manganese oxide	0.88	0.25	0.15	0.14
Alumina	0.14	0.30	1.08	1.80
Lime	0.06	0.65	4.20	1.05
Magnesia	0.20	0.10	.....	.....
Potash and soda	0.12	0.15	0.40	1.18
Silica	7.90	7.70	12.55	6.85
Phosphoric acid	0.09	Trace.	0.17	0.07
Sulphuric acid	Trace.	.....	Trace.	0.16
Water (by difference)	0.56	1.00	0.95	0.96
Total	100.00	100.00	100.00	100.00
Metallic iron	63.03	62.89	56.35	61.45

c

Analysis No. 1 was made at the Smithsonian Institution (?); No. 2, by Dr. Hood, San Francisco; No. 3, at the
d Royal School of Mines, London; No. 4, by the state assayer of Massachusetts.

Copies of the above were kindly furnished me by Mr. Adams.

The difference in the per cent. of phosphorus in my sample and in that of the specimens analyzed elsewhere is so great that Mr. Whitfield made a duplicate determination of the phosphorus in sample No. 1173, resulting in phosphorus 1.890 per cent.

IRON ORE IN OREGON.

In the southwestern part of the state, in the Sierra Nevada mountains, near the California state line, magnetite is reported to have been found, and it probably exists at various points in the Cascades. Bog-ore occurs in the valleys of the Columbia and Willamette rivers in considerable quantities, and this ore may prove an important
e source of iron on the Pacific coast.

Two and a half miles from the Oswego blast-furnace, the location of which has already been described, is a very peculiar body of ore, consisting of a bed of bog-ore intercalated in basalt. It is known as the *Prosser* mine. The foot-wall rock is vesicular, and was evidently the uppermost layer of an overflow. The ore was deposited in a depression in this rock, and was then covered by another basaltic flow. Afterward the whole formation was tilted up to its present position (Fig. 225). The vein dips northwesterly at an angle of about 20°, and outcrops along the

f

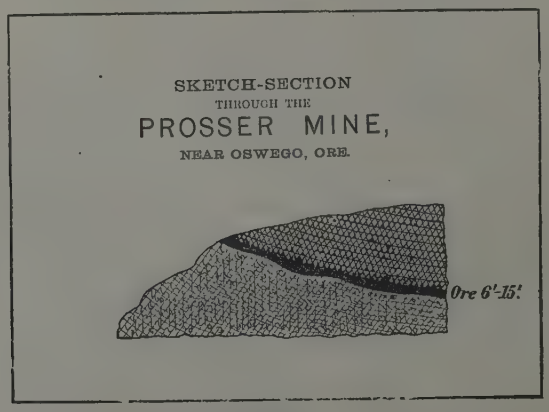


FIG. 225.

a north side of a valley for three-quarters of a mile or more. Many openings have been made along the outcrop, and the ore has been taken out in some places to a depth (on the vein) of 100 feet. The principal opening now consists of a slope 600 feet long on the dip of the vein, from which stopes have been driven westward for a distance of 150 feet. The foot-wall or floor of the mine is very rolling, but the roof is quite regular and even. The thickness of the ore varies from 6 to 15 feet. Between the ore and the roof there is often a layer of very argillaceous material which softens on exposure to the air and scales off. Above this the rock is generally firm, and very little timbering is required. The ore is exploited cheaply. From the mine-cars it is dumped into pockets, from which it is loaded directly on the cars for transportation to the furnace.

A quarter of a mile east of the main opening preparations are being made to drive another slope, but no ore b has yet been mined here.

With present developments the Oswego Iron Company estimates the capacity of the mine at 20,000 tons a year. It has never been worked, however, for twelve consecutive months, as the furnace has not required so much ore. During the census year the mine was in operation but 3⅔ months (*i. e.*, from June 16 to October 3, 1879), and in this time 6,225 tons of ore were raised.

The ore is a limonite, earthy in texture in the main, but containing bunches of a solid, dark-colored, crystallized ore. The latter forms but a small proportion of the mass. Samples of the ore yielded, on analysis—

c

	1165.	1167.
	Per cent.	*Per cent.*
Metallic iron	44.71	54.19
Phosphorus	0.666	0.392
Phosphorus in 100 parts iron	1.490	0.723

Sample No. 1165 is from a pile of 150 tons of ore in the stock-house at the furnace. Sample No. 1167 consists of selected chippings of the crystallized ore.

Within a half mile of the furnace, on land belonging to Mr. Patton, several thousand tons of ore were mined for the old furnace company. This ore was a bog-ore also, and it was deposited probably comparatively recently. It lies horizontally, and is covered with a few feet of sand and gravel only. A sample was taken from a pile of about d 50 tons of this ore near the furnace. It contains—

	1166.
	Per cent.
Metallic iron	45.40
Phosphorus	0.576
Phosphorus in 100 parts iron	1.269

e

IRON ORE IN WASHINGTON TERRITORY.

Deposits of bog-ore are quite numerous near the shores of Puget sound. In Chimicum valley, 2½ miles from the Irondale furnace, on Port Townsend bay, quite an extensive mass of this ore occurs, which has been exploited to some extent for the use of the furnace. Many acres of the valley bottom appear to be covered with a layer of ore from 10 to 20 inches in thickness, lying immediately under the grass roots. Estimating 14 cubic feet of ore to the ton, there are about 4,500 tons of ore on each acre of land. Mr. Moor, the superintendent of the furnace, told me that he had measured over 75,000 tons of ore in this valley, the mineral right of which is leased to the Puget Sound Iron Company for a term of fifty years on a royalty of 25 cents per ton of ore mined. The ore can be delivered by team to the furnace at $1 20 per ton. By building a tram road, it is estimated that this price can be reduced to 75 cents. The ore is porous, but sufficiently solid to permit of its being dug in large lumps. A portion of the f powdered ore is lifted by the magnet. A sample taken from a pile of 300 tons at the furnace contained—

	1168.
	Per cent.
Metallic iron	41.83
Phosphorus	0.751
Phosphorus in 100 parts iron	1.795

a A copy of an analysis of this ore by Mr. Regis Chauvenet, of Saint Louis, was given me by Mr. Charles Simpkins, treasurer of the Puget Sound Iron Company. It is as follows:

	Per cent.
Water	21.42
Silica	8.54
Phosphoric acid	1.433
Sulphur	0.005
Metallic iron	46.02
Phosphorus	0.624
Ratio of iron to phosphorus	100 : 1.355

b

Magnetite is reported in the Snoqualmie pass, and on Cypress and San Juan islands. A sample of ore from the latter locality was analyzed by Mr. Regis Chauvenet in April, 1880, with results as follows: (*a*)

	Per cent.
Water	4.38
Silica	21.85
Phosphoric acid	5.177
Sulphur	0.042
Metallic iron	46.56
Phosphorus	2.255
Ratio of iron to phosphorus	100 : 4.843

c

The percentage of phosphorus is large and renders the ore of little value.

BRITISH COLUMBIA.

There is an important deposit of magnetite ore on Texada island, in the straits of Georgia, between Vancouver island and the mainland of British Columbia, 120 miles from Port Townsend, which, although in British territory, d is of interest to the United States, as the ore will probably be smelted within its borders. The Puget Sound Iron Company, it is said, has a lease of the mines for three years, at a royalty of 25 cents per ton, agreeing to take not less than 5,000 tons per year. Texada island was visited by Mr. James Richardson in 1873, and mention is made of the iron-ore deposits in the *Report of Progress for* 1873–1874 *of the Geological Survey of Canada*, p. 99. Mr. Richardson finds the ore to be, in some places, associated with a coarse-grained epidotic rock and gray diorite, in others with a gray crystalline limestone, with which it is interstratified. Mr. George Hargreaves, civil engineer, of Victoria, British Columbia, who surveyed this property in 1874, estimated that there were 11,250,000 tons of ore on the island in four deposits.

Mr. D. W. Moor, the superintendent of the Puget Sound Iron Company, reports (*b*) the following measurements e of ore outcrops:

No. 1, *Vein*, commences 600 feet from the sea; width of ore from 15 to 20 feet; runs 200 feet uncovered; the depth can only be told by working.

No. 2, *Hill*, 900 feet from the sea; foot 300 feet perpendicular above water-line; at the base measures 50 feet front; runs 300 feet at a rise of 60° to top, thence 350 feet on level, with width of 90 feet on top; measured thickness of 14 feet; with 8 cubic feet to the ton, this hill shows 100,000 tons in sight.

No. 3, *Hill*, 1 mile from sea; has face 280 feet; runs uncovered 400 feet; thickness, 20 feet. Two knobs come in within 100 feet of this deposit, with 100 feet face, 300 feet long, with thickness of 24 feet; 300,000 tons on No. 3 in sight.

No. 4, *Hill*, 1 mile from the sea, consists of two veins with rock formation; ore 10 to 20 feet in each vein; covered with loose black ore, estimated at 100,000 tons.

I can safely say that there are 500,000 tons of ore in sight, besides the place that we are working now, which is within 300 feet of the f sea, and has a face 20 to 30 feet. A large portion of the above ore can be carried to the sea with double track, the loaded car returning the empty one.

About 600 tons of ore have been brought to Irondale, and are piled on the wharf. A sample from this pile contained—

	1169.
	Per cent.
Metallic iron	65.53
Phosphorus	0.013
Phosphorus in 100 parts iron	0.020

a I am indebted to Mr. Simpkins for a copy of this analysis.

b *Prospectus of the Puget Sound Iron Company*, p. 3.

The ore sampled is a fine granular black magnetite, and contains considerable pyrite. It would appear, however, from the following analyses of other samples, that some of the ore on the island is free from the latter mineral:

	By E. J. Chapman(*a*).	By Regis Chauvenet.(*b*)
	Per cent.	*Per cent.*
Protoxide of iron	28.33	.....
Peroxide of iron	67.31	.....
Oxide of manganese	Trace only.	.....
Titanic acid	0.11	.....
Phosphoric acid	0.07	0.128
Sulphuric acid	0.09	.....
Silica and silicious matter	3.97	1.44
	99.88	.....
Metallic iron	69.00	66.96
Phosphorus	0.030	0.056
Sulphur	0.036	Trace.

a Report on Texada Iron Mines, p. 14.
b Copy given me by Mr. Charles Simpkins.

b

IRON ORE IN ARIZONA.

c

Professor Newberry (*a*) reports the occurrence of specular ore in Monument and Mojave cañons, near the Colorado river, and limonite and magnetite have been found at several localities in the southern part of the territory near Dos Cabezas. Mr. J. G. Gilbert (*b*) observed the latter ore, "probably in quantity to give it economic value," in the schists underlying Paleozoic strata. Iron ore probably exists in many parts of the territory, and will doubtless become known as soon as it is considered of any economic value. It is possible that the gossans of many metalliferous veins will make excellent Bessemer ore.

IRON ORES IN NEW MEXICO.

d

Iron ores occur in beds and as float-boulders in the form of carbonate and hematite in the Coal Measures; as magnetic iron ores they accompany the gold-bearing formation. Every gulch and river in this formation contains magnetic iron sand, the "marmaje" of the Mexicans, and pebbles and boulders of great purity, the "tepurtite" or "la guia del oro" of the native miner. Large lodes of it with huge croppings are found together, with gold veins at the Moreno mines (Nacita gulch); at the south side of the Old Placer mountains the Mammoth lode contains such ore. In the New Placer mountains, east of Tuerto, are very extensive croppings of pure magnetite; and immense quantities of it exist at the Hanover copper mines near Pinos Altos, while a large lode of specular iron ore has been found of late near Embudo (between Taos and Santa Fé).—(Raymond, *Mining Statistics, etc.*, 1870, p. 417.)

At Santa Fé I was told that there were large deposits of iron ore in Los Cerrillos, a low range of mountains 18 miles south of Santa Fé, and between it and Galisteo. I found there several outcrops of narrow veins of magnetite in granite. The largest one seen, near the "Union shaft", is 18 inches wide. The surface is covered with soil, so that its longitudinal extent was not apparent. Sample No. 1174 consists of chippings from this outcrop. The ore e is a rather fine-grained, partly-weathered magnetite, with layers of carbonate of lime. Just before leaving the camp I was shown a piece of limonite of good appearance, a body of which I was informed had been found in these mountains. It is probably the gossan of a sulphuret vein.

North of Santa Fé, in the eastern part of Rio Arriba county, on the Santa Cruz creek, east of the town of Santa Cruz, a 2- to 4-foot vein of magnetic ore is reported.

On the mountains east of Santa Fé creek, about 3 miles from Santa Fé, there is said to be a vein of magnetite 2 feet wide in red granite (?), which is traceable for several hundred yards. A specimen of this ore consists of one-half of magnetite and the other half chiefly of quartz, and is of no value as an ore of iron. It is interesting, however, as indicating the kind of rock which has been the source of the magnetic sands of the gulches. These sands have in all probability been derived from a magnetite-bearing rock, through its disintegration, and not from f a solid body of ore of commercial value.

On the Maxwell land grant, near Elizabethtown, about 30 miles from Cimarron, is a hill locally known as "Iron mountain". Its sides are said to be covered with float-ore, and it has always been supposed to contain a large deposit of magnetite. The locality was examined, however, by Professor St. John (of Topeka, Kansas) during the summer of 1880, who reported (*c*) that the hill contained only a narrow vein 2 to 3 feet in thickness, and the quantity of ore was too small to be practically valuable. I am indebted to Mr. Springer for some specimens of this ore, collected by Professor St. John. Sample No. 1175 consists of these specimens.

a In *Report on the Geology of Lieutenant Ives' Colorado Exploring Expedition* (Washington, 1861).
b Geological and Geographical Survey West of the 100th Meridian, George M. Wheeler in charge, Vol. III, p. 510.
c So I was told by Mr. Springer, agent of the Maxwell Land Grant Company.

a A small vein of magnetite is also reported on Cimarron Cito creek, but it is believed to be of no value. Carbonate of iron and its weathered product exist, associated with the coal at many points on the grant; but whether in a sufficiently thick seam to be of value I did not learn. A similar ore occurs near Galisteo, and elsewhere in the territory wherever coal has been found.

The samples of ore collected in New Mexico contained—

b

	1174.	1175.
	Per cent.	*Per cent.*
Metallic iron	65.59	56.80
Phosphorus	0.008	0.051
Phosphorus in 100 parts iron	0.012	0.090

In the following table the deposits of ore which were not visited, and opposite which no authority is mentioned, were reported to me in conversation, and no definite information in regard to them was obtainable. It is more than probable, therefore, that the list contains some localities where workable bodies of ore do not exist. Undoubtedly, also, there are many deposits of considerable size, known to prospectors, of which I have no reports. I am indebted to Mr. D. A. M. Froiseth, of Salt Lake City, for much information in regard to the iron ores of Utah. The following contractions have been used in the column headed "*Authority and general remarks*":

c "Ives Report."—*Report upon the Colorado River of the West*, explored in 1857 and 1858, by Lieutenant J. C. Ives, Corps of Topographical Engineers, Washington, U. S. A., 1861.

"Browne."—Report of J. Ross Browne, *on the Mineral resources of the States and Territories West of the Rocky Mountains* (Washington, 1868).

"Blake."—*Report of a Geological Reconnaissance in California*, by William P. Blake (New York, 1858).

"Whitney."—*Geological Survey of California.* J. D. Whitney, State Geologist, Vol. I (1865).

"Raymond."—*Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains*, by Rossiter W. Raymond, U. S. Commissioner of Mining Statistics.

Iron ores in Colorado.

d

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Huerfano county: Grayback gulch, 5 miles from Placer station; 4 miles from Denver and Rio Grande railroad.	Colorado Coal and Iron Company.	*Ore:* Magnetite (oxidized near outcrop). *Rock:* Limestone.	Carboniferous (Hayden).	1108 1108*a* 1109 1110	Ore has been taken from two openings, known as the Ainsworth and the Stoddard mines.
Huerfano county: On plains near Walsenburg.		*Ore:* Carbonate and derivatives.	Cretaceous	1112 1113	Nodules of partially weathered carbonate of iron, derived from the coalseries by erosion and degradation of the inclosing rock, are found in considerable quantities on the surface of the plains near the coal seams.
e *Las Animas county:* Coal mine near El Moro; on railroad.	Colorado Coal and Iron Company.	*Ore:* Carbonate and derivatives. *Rock:* Shale and sandstone.	Cretaceous	1111	Seam of ore 6 inches thick.
Fremont county: On Pine creek, near Grape creek, 22 miles from Cañon City; 4½ miles from Cañon City and Silver City branch of Denver and Rio Grande railroad.	Colorado Coal and Iron Company.	*Ore:* Magnetite (titaniferous). *Rock:* Granite.	Archæan	1114 to 1120	
Saguache county: Western foot-hills of the Sangre de Cristo mountains 5 miles south of Hayden's Pass, 8 miles southeast of Villa Grove; 25 miles from Gunnison extension of Denver and Rio Grande railroad.		*Ore:* Limonite *Rock:* Limestone.		1121 to 1125	
Saguache county: On road between Saguache and Lake City, about 20 miles f west of Saguache.		*Ore:* Limonite (?)			Reported to me by a teamster.
Chaffee county: In Arkansas hills, 9 miles from South Arkansas via Ute Pass; 9 miles from railroad.	Colorado Coal and Iron Company.	*Ore:* Magnetite *Rock:* Trachyte.		1176 and 1176x	Three claims have been entered under the following names: Calumet, Hecla, Smithfield.
Chaffee county: Near Garfield and near Cleora.		*Ore:* Magnetite and hematite.			Reported to me in conversation. No developments have been made, and extent of deposits are not known.
Park county: Near Hamilton		*Ore:* Magnetite		1132	Reported to me by letter. Sample of the ore was mailed to me from the Holland smelter; locality was not visited.
Park county: Near Buffalo park, 15 miles west of salt-works.		*Ore:* Limonite (?)			Reported to me in conversation. No definite information obtainable.
Lake county: Breece mine, near Leadville; 2½ miles from railroad.		*Ore:* Specular hematite *Rock:* Porphyry.	Mesozoic (Emmons).	1126 to 1128	

Iron ores in Colorado—Continued.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Jefferson county: "Jefferson County" Iron mines, near Morrison; 2 miles from railroad.		*Ore:* Magnetite in amphibole. *Rock:* Amphibole schist, granite, and gneiss.	Archæan	1107	
Boulder county: Near Caribou; 20 miles from railroad (at Boulder).		*Ore:* Magnetite. *Rock:* Granite.	Archæan(?)	1105 and 1106	
Boulder county: Near Marshall Coal mine, 5 miles south of Boulder; on railroad.		*Ore:* Carbonate and derivatives. *Rock:* Shale and sandstone.	Cretaceous	1104	See note to 1112 and 1113.
Routt county: In Coal mountain, on the White River divide, south of Yampa peak.		*Ore:* Carbonate and derivatives.	Cretaceous		*Geological Explorations Fortieth Parallel*, Vol. II, p. 279. 6-inch seam.

Specimens of specular ore have been found in Plum and Elk creeks, Cheyenne mountain (near Colorado Springs), and on Pike's Peak, but no mass of het ore is known to exist in the vicinity.

Iron ores in Wyoming.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
In the Laramie hills, 40 miles northwest of Cheyenne; 20 miles from Laramie City, on Union Pacific railroad.		*Ore:* Titaniferous magnetite and ilmenite. *Rock:* Granite.	Archæan		*Geological Exploration Fortieth Parallel*, Vol. II, pp. 15 and 16.
Two and one-half miles from Rawlins station; 2½ miles from Union Pacific railroad.	Messrs. Shaw & Friend.	*Ore:* Hematite. *Rock:* Sandstone.	Lower Palæozoic	1133 and 1134	*Geological Exploration Fortieth Parallel*, Vol. II., p. 161.
Near Evanston coal-mines; on railroad		*Ore:* Carbonate and derivatives. *Rock:* Shales and sandstone.	Cretaceous		Ore in thin layers and in nodules, as in Colorado. Of no commercial value.
Along Bitter creek, near Leucite hills		*Ore:* Carbonate and derivatives. *Rock:* Shales and sandstone.	Cretaceous		*Geological Exploration Fortieth Parallel*, Vol. II, p. 233. Fragments of concretionary brown hematite.
Two miles west of Salt wells, at the Vandyke (coal) mines.		*Ore:* Carbonate and derivatives. *Rock:* Shales and sandstone.	Cretaceous		*Geological Exploration Fortieth Parallel*, Vol. II, p. 234. Four feet of coal is overlaid by a red iron-stained sandstone containing thin beds of limonite.

Iron ores in Dakota.

Slim seams of specular ore were found by Newton in the Archæan slates of the Black Hills, and nodular pieces of carbonate were observed associated with the Cretaceous coals, but no workable deposits of ore in the territory have been reported.

Iron ores in Utah.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Iron county: Near Iron City and Iron Springs, in Ts. 35, 36, 37 S., Rs. 12, 13, 14 W., 7 to 20 miles west from Cedar City; 40 miles from railroad (at Milford).	Thomas Taylor	*Ore:* Magnetite and "hematite". *Rock:* Trachyte, granite, and limestone.	Lower Silurian (?) (Newberry).	1141 to 1154	Some of the ore was smelted in Iron City between 1869 and 1875.
Beaver county: In the Wah Wah mountains, 20 to 25 miles SW. of Frisco, [about T. 30 S., R. 15 W.]; 22 miles from railroad (at Frisco).		*Ore:* "Hematite and magnetite. *Rock:* Granite (?).		1135	Reported to me at Frisco. Bowen's mine (sample No. 1135) is on the east slope of the Wah Wah mountains, 22 miles from Frisco, and was opened in the fall of 1880, and some ore (hematite) was shipped to the Frisco smelters for flux. A little ore has also been sent from Mooney's mine, 6 miles west of the above and on the ridge of the mountains. The localities were not visited.
Beaver county: On west slope of Frisco mountains, 6 miles from the town of Frisco, about T. 27 S., R. 13 W.		*Ore:* "Hematite"			Reported to me at Frisco. Explorations were begun here in November, 1880, in search of a good flux for the smelters.
Beaver county: Star district; Vulcan mine, in southern part of district, 7 miles southwest of Milford, about T. 27 S., R. 13 W.		*Ore:* Limonite		1137	Sample collected at Frisco smelter. Ore is reported to contain silver.
Beaver county: Lake Superior mine, in northern part of district, about 7 miles from Milford, about T. 28 S., R. 11 or 12 W.; 3 miles from railroad.	Forgie Brothers (of Frisco).	*Ore:* Magnetite. *Rock:* Quartzite and granite.		1140	Explorations made and claim entered for copper ore. A little iron ore has been teamed to the Frisco smelters.

Iron ores in Utah—Continued.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Beaver county: Rocky District; the Frisco Mining and Smelting Company's mine, 4 miles from Milford [about T. 27 S., R. 11 W.]; 1 mile from railroad.	Frisco Mining and Smelting Company.	*Ore:* Magnetite ..... *Rock:* Quartzite and granite.	.....	1139	Searching for copper ore is the chief work of the camp, but several hundred tons of iron ore have been mined and teamed to Frisco.
Beaver county: Bradshaw district; Cave mine, 7 miles southeast of Milford, [about T. 29 S., R. 9 (or 10) W.].	Frisco Mining and Smelting Company.	*Ore:* Limonite.....	.....	1138	Ore carries about $20 worth of silver and gold to the ton. It is not, therefore, commercially speaking, an ore of iron. It is used for flux at Frisco, where sample was taken. The locality was not visited.
Sevier county: In Castle valley, about T. 22 S., R. 6 E.	.....	.....	.....	.....	Ore is reported to occur near the coal, and is probably, therefore, an altered carbonate of Cretaceous age.
Juab county: On west slope of divide between east and west Tintic valleys, in T. 11 S., R. 3 W.	.....	.....	.....	.....	Reported to me at Tintic.
Utah county: East Tintic district; 16 to 24 miles west of Sautaquin station, in divide between Goshen and East Tintic valley, in T. 10 S., Rs. 2 and 3 W.; 16 to 24 miles.	See description of mines.	*Ore:* Limonite..... *Rock:* Limestone and porphyry (?).	.....	1155 to 1160	Mining operations have been carried on here for two or three years. Ore used for flux; chiefly at Sandy.
Utah county: Cedar Valley district; about 15 miles west of Lehi station, in T. 4 S., R. 2 (or 3) W.; 15 miles from railroad.	.....	.....	.....	.....	
Tooele county: Columbia district; about T. 9 S., R. 6 (or 7) W.	.....	.....	.....	.....	
Tooele county: West of the above, in T. 9 S., R. 6 W.	.....	*Ore:* Specular	.....	.....	
Tooele county: Stockton or Rush Valley district; in T. 4 S., R. 4 West; about 3 miles from railroad.	.....	.....	.....	.....	
Tooele county: On the east slope of the Onaqui mountains, near Grantville, in T. 2 (or 3) S., R. 6 (or 7) W.; about 15 miles from railroad.	.....	.....	.....	.....	
Tooele county: Skull district; on the west side of Skull valley, near the Onaqui mountains, 2 miles east of Hooper's ranch; about 20 miles by nearest road, over the Onaqui mountains.	.....	.....	.....	.....	Marked "Iron mountain" on Froiseth's Map of Utah (1878).
Salt Lake county: Adams district; in City Creek cañon, 10 miles from Salt Lake City, in T. 1 N., R. 2 E.	.....	.....	.....	.....	
Salt Lake county: Antelope district; on Antelope or Church island, about 18 miles northwest of Salt Lake City, in T. 2 (or 3 N.), R. 3 W.	.....	.....	.....	.....	
Salt Lake county: Cottonwood district; in Flagstaff mine [T. 2 S., R. 2 E.].	.....	*Ore:* Limonite.....	.....	.....	A low-grade silver ore; has been used for flux. Mine is now idle.
Morgan county: Mill Creek district; 10 miles south of Weber station, on Union Pacific railroad), and 21 miles from Salt Lake City [T. 3 N., R. 2 W.].	Norway Iron Mining and Manufacturing Company.	.....	.....	.....	Ore is reported to contain gold.
Weber county: In Ogden cañon, 2½ miles north from Ogden City [T. 6 N., R. 1 W.].	.....	*Ore:* Hematite..... *Rock:* Quartz.	Archæan? Cambrian?	1161	
Weber county: In Cold Creek cañon, 7 miles north from Ogden City, via Ogden cañon [T. 6 N., R. 1 E.].	.....	*Ore:* Hematite..... *Rock:* Quartzite and slate.	Devonian?.....	1162	
Weber county: In Strong's cañon, 3 miles from Ogden City, near top of mountains overlooking Salt lake.	.....	*Ore:* Specular	.....	.....	
Weber county: 3 miles east of Huntsville, and 14 miles east of Ogden City, via Ogden cañon [T. 6 N., R. 2. E.].	.....	*Ore:* Hematite	Cambrian?.....	.....	The Cambrian plateau extends "across Logan, Blacksmiths, and Muddy cañons, as far south as Ogden river, occupying a belt 6 to 8 miles in width." "The presence of iron in considerable amounts would appear to be highly characteristic of the Cambrian formation. It occurs disseminated through the rock in thin seams or cracks, and in small concretionary masses, usually, however, decomposed into yellow ochreous earth. In the stream-beds of the North fork of the Muddy, and on the lower slopes of the ridges, were found fragments and rounded pebbles of specular iron; also, in the Cambrian quartzite on Mill creek, which runs to Morgan valley, similar fragments were found. It is not improbable that future explorations may discover iron masses of considerable economic importance." (*Geological Exploration Fortieth Parallel*, Vol. II, pp. 412 and 413.)
Box Elder county: On Willard mountain, 2¾ miles from Willard station, on Utah and Northern railroad [T. 8 N., R. 1 W.]; about 3½ miles by road.	.....	*Ore:* Specular	Cambrian?.....	1163	About 7,000 tons of ore have been taken out from this mine.
Box Elder county: In Willow creek cañon, 3 miles from Willard station; 3 miles from railroad.	.....	*Ore:* Hematite (limonite)? *Rock:* Limestone.	Silurian?.....	.....	A pocket of hematite in limestone was discovered some five or six years ago and worked out. The ore was shipped to Sandy for flux.

Iron ores in Utah—Continued.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Box Elder county: In the Idaho and other mines, opposite the city of Corinne; 2 miles from the Utah and Northern railroad.	.....	.....	.....	.....	
Caché county: Mineral Point district; about 75 miles north of Salt Lake City [T. 10 N., R. 2 and 3 E].	.....	.....	.....	.....	b

NOTE.—Also traces of iron ore have been found in Melville, Logan, and Dry Lake mining districts, all in Caché county.

Iron Ores in Nevada.

Eureka county.—In Palisade cañon, 3 miles west of Palisade station. Magnetite in trachyte *Geological Explorations 40th Parallel*, Vol. II, p. 585, 586.

Lander county.—About 15 miles south of Battle mountain a small vein of magnetic (?) ore is reported.

White Pine county.—In Robinson mining district deposits of "hematite" and magnetite are said to exist near road between Pioche and Eureka.

Humboldt county.—In Jackson mountains, 40 miles northwest of Humboldt station. Magnetic ore (see sample No. 1164).

Churchill county.—Near White Plains specular hematite is reported.

In the Mineralogical tables, in Vol. III, *U. S. Geographical Surveys West 100th Meridian*, Lieutenant George M. Wheeler in charge, p. 654, the occurrence of hematite and limonite at "Lone mountain", of menaccanite (titaniferous oxide of iron) at Carlin, Eureka, Morey, Belmont, and of magnetite at Iron springs, Wheeler's peak, and Railroad district is noted. c

"The surveyors employed by the Central Pacific Railroad Company report the discovery of extensive beds of magnetic iron ore within a short distance of the line of the road, near Crystal Springs; also at Neilsbury, within a mile of the road, and at Long valley. There are many other districts in Nevada which contain iron ore. There is a series of regular veins of specular ore from 8 to 20 feet thick, near the East fork of Walker's river, in Esmeralda county."—*Mineral Resources of States and Territories West of Rocky Mountains.* By J. Ross Browne, 1868, p. 225.

Iron Ores in California (Exclusive of Chromic Ores).

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
San Diego county: Purple hills, near the Colorado river.	.....	*Ore:* Specular.....	.....	.....	Newberry, in Ives' Report, p. 21. d
San Diego county: Near San Diego.....	.....	.....	.....	.....	Newberry in Ives' Report, p. 151.
San Diego county: On ranch belonging to Sisters of Charity, 16 miles from city of Los Angeles.	Sisters of Charity ..	*Ore:* Specular and magnetite. *Rock:* Clay slate.	.....	.....	Brown, p. 224. "The ore presents itself on the surface for nearly a mile in a stratum averaging 15 feet thick, inclosed in hard metamorphosed clay slate."
Los Angeles county: Williamson's pass ..	.....	.....	.....	.....	Blake, p. 289. "Large rolled masses of magnetite were picked up in the bed of one of the streams entering the valley of Williamson's pass, on the east side. The ore is very pure and crystalline, and is associated with hornblende, cinnamon-colored garnets, and chlorite. It probably exists in a considerable vein between the pass and the Cajon." e
San Bernardino county: In the Coast range.	.....	*Ore:* Specular.....	.....	.....	Brown, p. 222.
Kern county: In the Cañada de las Uvas, in the Sierra de Rafael mountains, near Fort Tejon.	.....	*Ore:* Magnetite ..... *Rock:* Limestone.	.....	.....	Blake, p. 289. "Magnetic iron ore occurs in a vein about 3 feet thick in a low ridge of white crystalline limestone, in the valley of the pass known as the Cañada de las Uvas. This ridge is near the highest point of the pass, and the débris of the ore rolls down close to the trail. The vein or bed of ore is nearly vertical, its trend is nearly east and west, and the outcrop is traceable for about 30 feet. The ore is much mixed with carbonate of lime, but no other minerals of association were observed. It is compact, but not crystalline. When broken, it shows a brilliant fracture, with a granular surface, and does not cleave with broad, flat faces, as in the massive ores of New York and New Jersey." f Whitney, pp. 194. "Several miles down the valley, southwest of the summit of the pass of the Cañada de las Uvas, the limestone belt is in places accompanied by a belt of ferruginous metamorphic rock containing magnetic oxide of iron, and a similar rock was seen associated with the limestone of the San Emidio Cañon." Referred to also on p. 189.
Kern (or Los Angeles) county: On shore of lake Casteca, southwest of fort Tejon.	.....	*Ore:* Magnetite ..... *Rock:* Limestone.	.....	.....	Blake, p. 210. There is a vein of iron ore intercalated in one of the limestone ridges bordering the lake.
Santa Barbara county: In the Santa Iñez valley.	.....	*Ore:* Magnetite.....	.....	.....	Brown, p. 224.
Santa Cruz county: In the coast range near the sea, a few miles north of town of Santa Cruz.	.....	.....	.....	.....	Brown, p. 222.

a *Iron Ores in California (Exclusive of Chromic Ores)*—Continued.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Merced county: Near Burns creek, a tributary of the San Joaquin river.		*Ore:* Limonite *Rock:* Quartz.			Blake, p. 14. Blake reports this vein of ferruginous quartz to be 25 feet thick. From his description it probably is too silicious to make an ore of iron.
Calaveras county: Near Murphy's		*Ore:* Hematite *Rock:* Limestone and slate.	Mesozoic		Whitney, p. 259. "Near the line of contact between the limestone and slates are quite extensive deposits of hematite iron ore, which have not been opened or worked at all, and whose exact extent cannot therefore be known. Were fuel abundant and labor cheap, this deposit might become of importance."
b *Calaveras county:* Five miles from Calaveras.					Raymond, 1870, p. 29. "The discovery of extensive iron-ore deposits 5 miles from Calaveras is reported."
Amador county: Near Ione City		*Ore:* Hematite (?), limonite (?). *Rock:* Sandstone.	Tertiary (?)		Whitney, p. 270. "This member of the formation contains so much iron in places as to become a tolerable ore; in other localities it forms a quartzose breccia, cemented by brown oxide of iron."
c *Eldorado county:* Near Volcanoville, on the Middle fork of the American river.					Blake, p. 289. "Large masses of magnetic iron ore occur in a slight ravine among boulders of quartz and other rocks, near the great vein of auriferous quartz at Volcanoeville. Their source is not known, but it is probably in the vicinity. It must form a thick bed, judging from the size and number of the transported masses."
Placer county: Four miles from Clipper Gap station, on Central Pacific railroad.	California Iron Company.	*Ore:* Magnetite and limonite. *Rock:* Limestone, slate, and diorite (?).	Mesozoic	1170 1171 1172	The pioneer blast-furnace of California has just been completed to smelt these ores.
Sierra and Plumas counties: In Gold valley, near Downieville; 47 miles from Truckee, on Central Pacific railroad.	Sierra Iron Company.	*Ore:* Magnetite *Rock:* Limestone and slate.	Mesozoic		Baron von Richthofen, Clarence King, H. D. Hague, quoted by Raymond, 1873, p. 91, and 1874, p. 44. Richthofen estimated the different deposits to contain 1,400,000 tons of ore.
d *Butte county:* Near Chapparal hill, near the Grizzly creek, a tributary to Butte creek, 46 miles miles from Oroville on the Susanville road.		*Ore:* Magnetite *Rock:* Slate and granite.			Brown, p. 224.
Napa county: 3½ miles from Saint Helena; 3½ miles from railroad.	Edson Adams	*Ore:* Hematite *Rock:* Jasper schist.	Mesozoic (?)	1173	
Shasta county: Near the head of Spring creek, north of Shasta City.		*Ore:* Hematite *Rock:* Slate.	Mesozoic		Whitney, p. 322. "Near the head of Spring creek large bodies of hematite iron ore occur [in the metamorphic slates], pure and of good quality, of which numerous boulders have been washed down the cañon. Under favorable circumstances as to fuel and labor, these deposits would be very valuable. The quantity and quality of the ore seem to be all that could be desired."
e *Shasta county:* Potter's iron mine, 2 miles northeast of United States salmon fishery on the McCloud river.					California State Mineralogical Museum.

Specimens of float magnetite have been sent to the State Mineralogical Museum from Sutter river, Amador county, near Tres Pinos, San Benito county, and from points in Butte and Yuba counties. Hematite is reported in the Kelsey tunnel, 14 miles from southeast of Crescent City, Del Norte county. Magnetic sand is known to exist at many points along the coast in large quantities.

Chromic iron ore in California.

Chromic iron ore has been found in pockets in serpentine rocks, of Mesozoic (Lower Cretaceous or Jurassic) age, at different localities along the Coast range and east of it. The body of ore occurring at any one point is usually small, so that a "mine" is soon exhausted. The following list of localities, which is doubtless very incomplete, is taken chiefly from the labels of specimens in the State Mineralogical Museum, San Francisco:

San Luis Obispo county.—Near the city of San Luis Obispo a large amount of ore has been mined from numerous openings; also near San Juan.

f *Fresno county.*—Five deposits, within 20 miles of Fresno city.

Monterey county.—"Extensive beds of massive chromic iron ore are said to exist in the mountains of Monterey county" (Blake, p. 303), near Monterey. "Chromic iron may, however, be discovered sufficiently near to a place of shipment to become of value in time." (Whitney, p. 114.)

Santa Clara county.—Five miles east of San José, and near Los Gatos.

Alameda county.—East of San Antonio "considerable masses of chromic iron ore occur in this position, one of which was formerly worked to some extent." (Whitney, p. 19.)

Sonoma county.—Near Cloverdale; near Litton Springs; near Healdsburg.

Del Norte county.—Near Crescent City (probably the largest deposit of chromic iron ore thus far discovered in the state).

Calaveras county.—"On the south side of San Diego gulch, Calaveras county, on the crest of the highest hill, opposite the Noble copper mine, there is an isolated mass of this ore that will weigh thousands of tons." (Brown, p. 225.)

Amador county.—Near Jackson.

Sacramento county.—Seven miles east of Folsom.

El Dorado county,—Northwest of Shingle Springs.

Iron ores in Oregon.

a

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Josephine county: On Althouse creek, 4 miles north of California state line, in (about) T. 40 S., R. 7 W.		*Ore:* Magnetite			
Coos county: In (about) T. 27 S., R. 10 W., near Coaledo.		*Ore:* Magnetite			
Marion county: On Butte creek, in T. 6 S., R. 1 E.		*Ore:* Titaniferous magnetite.			b
Clackamas county: North of Clackamas river, in T. 4 S., R. 5 E.		*Ore:* Float limonite			
Clackamas county: 2½ miles from Oswego furnace, in T. 2 S., R. 1 E. Prosser mine. Railroad to mine.	Oswego Iron Company.	*Ore:* Bog-ore *Rock:* Basalt.		1165 1167	Bed of bog-ore intercalated between two basaltic flows.
Clackamas county: Half mile from Oswego furnace, in T. 2 S., R. 1 E. Patton mine.	M. Patton	*Ore:* Bog-ore		1166	
Multnomah county: Near Rooster rock, in T. 1 N., R. 5 E.		*Ore:* Magnetite (?)			
Columbia county: 3 miles northwest of Saint Helen's, in T. 5 N., R. 1 W.		*Ore:* Bog-ore (?)			
Clatsop county: 15 miles south of Astoria, in T. 6 N., R. 9 W.		*Ore:* Bog-ore (?)			c
Clatsop county: 6 miles south of Astoria, in T. 7 N., R. 10 W.		*Ore:* Bog-ore (?)			

Iron ores in Washington Territory.

Location and distance from the nearest railroad or navigable stream.	Owners or lessees.	Character of ore and associated rock.	Probable geological horizon of ore.	If sampled, the number of sample.	Authority and general remarks.
Thurston county: Southwest of Olympia, in (about) T. 17 N., R. 2 W.		*Ore:* Bog-ore			d
Jefferson county: Southwest of Port Ludlow, on the head of Dabop bay, in (about) T. 28 N., R. 1 W.		*Ore:* Bog-ore			
Jefferson county: Chimicum valley, 2½ miles from Irondale, in (about) T. 29 N., R. 1 W.		*Ore:* Bog-ore		1168	Used in furnace at Irondale.
Clallam county: In Gray's marsh, near Squiva bay, in (about) T. 30 N., R. 3 W.		*Ore:* Bog-ore			
King county: In the Snoqualmie pass, in (about) T. 22 N., R. 10 E.		*Ore:* Magnetite			
Snohomish county: On the Skykomish river, in (about) T. 27 N., R. 8 E		*Ore:* Bog-ore			
Snohomish county: Near town of Snohomish, in (about) T. 28 N., R. 5 E.		*Ore:* Bog-ore			
Whatcom county: On Nooksahk river, in (about) T. 39 N., R. 2 E.		*Ore:* Bog-ore (?)			e
Whatcom county: On Birch point, near Birch bay, in (about) T. 40 N., R. 1 W.		*Ore:* Bog-ore (?)			
San Juan county: On east side Cypress island, 200 yards from Bellingham straits, in (about) T. 36 N., R. 1 E.		*Ore:* Magnetite			
San Juan county: On Topez island, in (about) T. 35 N., R. 2 W.		*Ore:* Hematite *Rock:* Jaspery quartz.			
San Juan county: San Juan, in (about) T. 35 N., R. 3 W.		*Ore:* Magnetite			See analysis of ore in text.

Iron ores in Arizona.

Professor Newberry found specular ore in Monument and Mojave cañons, and hematite in the Diamond River cañon, also near the Colorado river.—*Geological Report of Colorado Exploring Expedition*, Lieutenant J. C. Ives in charge (1857–'58). f

In the mineralogical tables of Vol. III of the Geological Surveys west of the 100th meridian, Lieutenant George M. Wheeler in charge, mention is made of the occurrence of hematite on the Rio Francisco; of limonite on Rocker creek, a tributary to the Colorado river in the northern part of the territory; and near the town of Dos Cabezas (in the southeastern portion of the territory), and of titaniferous magnetite in the Dragoon mountains (southeast of Tucson); magnetite also occurs near Dos Cabezas.

Iron ores in New Mexico.

"Hematite has been found in the Burro mountains, near Silver City, and in the Placer mountains; limonite exists in the Madelina and Nacimiento mountains." (Wheeler, Vol. III, p. 65.)

Magnetite occurs in the Los Cimarron mountains, 22 miles south of Santa Fé (sample No. 1174), in the Placer and Los Deos mountains, on the Maxwell land grant near Elizabethtown (Colfax county), and near the Cimarron cito (sample No. 1175), and in the mountains near Santa Fé. Carbonate and limonite derived from it is found in the coal series near Galisteo (San Miguel county), and in the Raton mountains in Colfax county, near the Colorado State line.

ANALYSES

OF THE

SAMPLES OF IRON ORE COLLECTED FOR THE TENTH CENSUS

AND

DESCRIBED IN THE PRECEDING NOTES.

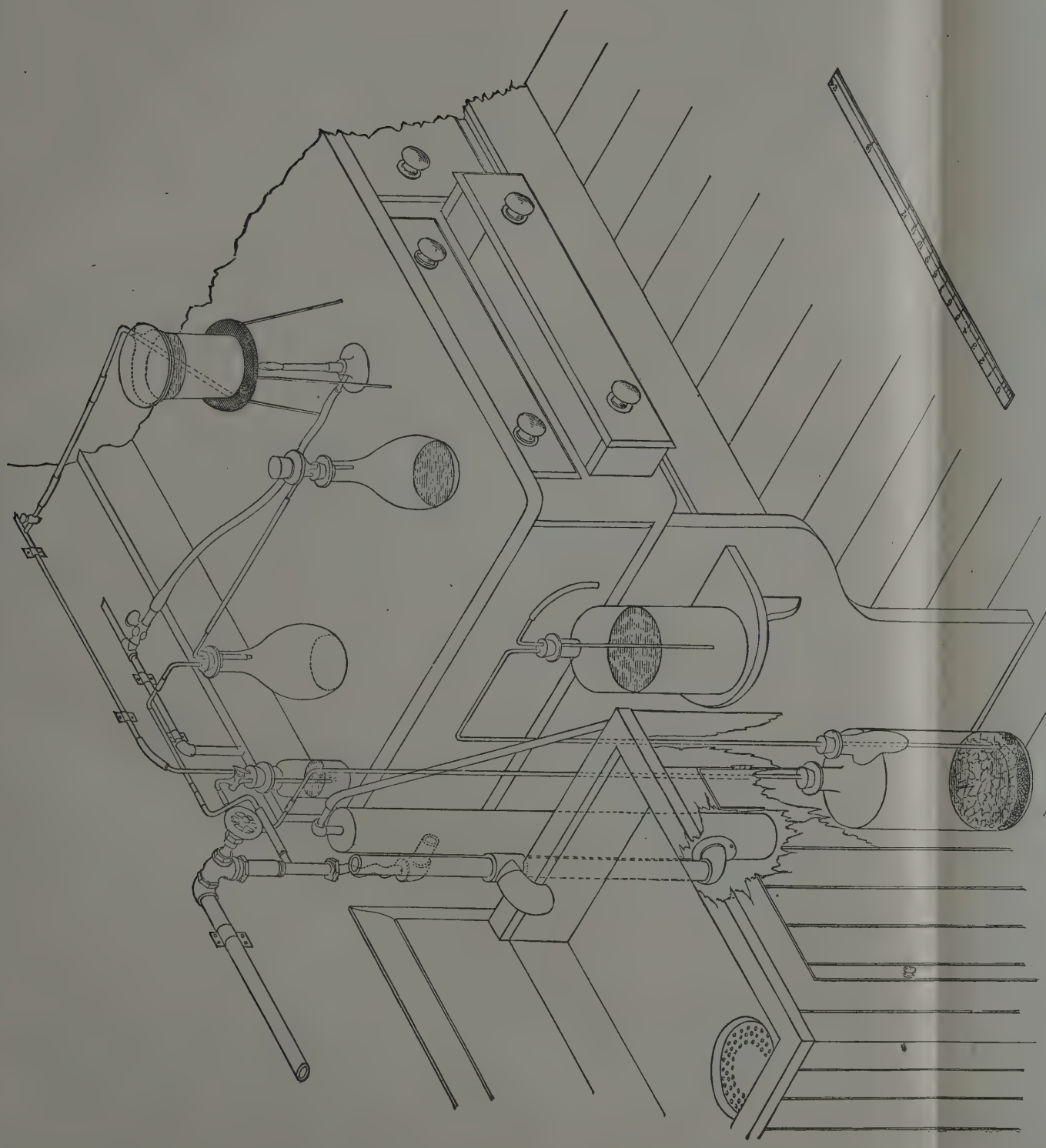


FIG. 226.—FILTER-PUMP AND CARBONIC-ACID GENERATOR.

THE METHODS EMPLOYED IN THE ANALYSIS OF THE IRON ORES,

TOGETHER WITH A

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID.

By A. A. Blair.

The treatment of samples of iron ore naturally divides itself into two parts, the mechanical and the chemical, and it will be described under these heads. The care with which the identity of every sample was preserved throughout will be shown, and the methods, by which the determination of the different elements was rendered as accurate as the state of chemical knowledge would allow, will be given in detail.

THE MECHANICAL TREATMENT.

The sample was first taken from the bag and placed upon a large piece of clean strong paper, and the label was removed from the box and put in a little card-rack fixed over the bench. Half a dozen small chips, representing as nearly as possible the different varieties of the ore, were put aside and carefully labeled, to be used for specific-gravity determinations, and for thin sections for the microscope.

The large steel mortar, Fig. 227, was half filled with the ore, the leather cover was adjusted, and the machinery was started. This mortar was cast at the Midvale Steel Works of Philadelphia, and was made of an exceptionally fine quality of propeller steel, containing over 1 per cent. of carbon and about fifteen thousandths of 1 per cent. of phosphorus. The pestle was forged and hardened, and the wear, after crushing between 15,000 and 20,000 pounds of ore, was scarcely perceptible in either mortar or pestle. The mortar weighed about 70 pounds, and the pestle with the stem and weight about 25 pounds. The tappets *a* were faced with raw-hide, which stood the wear of the cams H remarkably well, much better than either hard or soft iron or steel, the dust from the ore causing the latter to cut very fast. The shaft made about 90 revolutions per minute, and the ore, when the mortar was about half filled, fed itself, so that without any attention 25 pounds of hard ore in lumps was reduced almost to powder in about one and a half hour.

The stem B was hooked up so that the pestle cleared the top of the mortar A. The pulley D raised the mortar clear of the block, and by means of the traveler E the mortar was emptied on the chilled-iron plate F, as figured in the sketch. The ore was ground to a fine powder on this chilled plate by the hardened steel muller C, any of it falling off the plate being caught in the sheet-iron troughs G. It was thoroughly mixed and quartered, and the resulting sample, reduced finally to about 6 to 8 ounces, was placed in a clean, dry bottle. This bottle had the number of the sample etched upon it, the same number, in figures half an inch high, pasted on the neck, and the label which came in the sample bag pasted on its side. The bottle was not taken into the grinding-room until the sample was being ground, and was always previously numbered, so that when it was brought up-stairs with the label the numbers could be compared and the label pasted on. A portion of the sample was ground in the agate mortar A (Fig. 228) with an agate pestle, B, fitted in a flexible shaft, C, and revolving at the rate of 700 times a minute, transferred to a ground-glass stoppered bottle, and dried at 100° C. It was then ready for analysis.

THE CHEMICAL TREATMENT.

DETERMINATION OF PHOSPHORIC ACID.

For ores low in phosphoric acid 10 grams were dissolved in HCl, the solution was evaporated to dryness on the sand-bath, redissolved in dilute HCl (one part of acid to two of water), filtered, the filtrate treated with 10 c.c. NH_4HSO_3 (*a*) to reduce the iron to the ferrous condition, NH_4HO added until the solution was nearly neutral, and

a Made by saturating NH_4HO with SO_2, generated by heating powdered charcoal and strong H_2SO_4 in a flask. The mixture was made of the consistency of cream, and the gas passed first through a wash-bottle containing water.

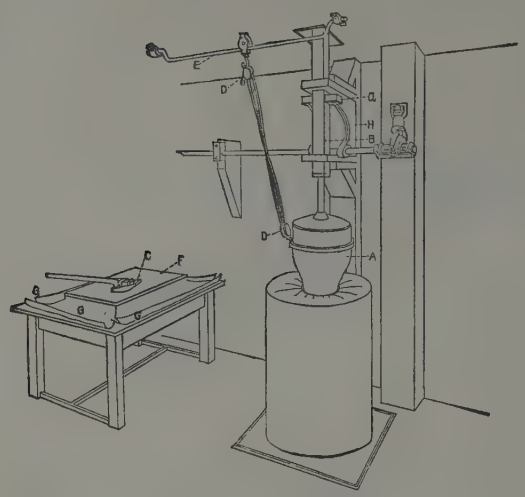


FIG. 227.—CHILLED PLATE AND STEEL MORTAR.

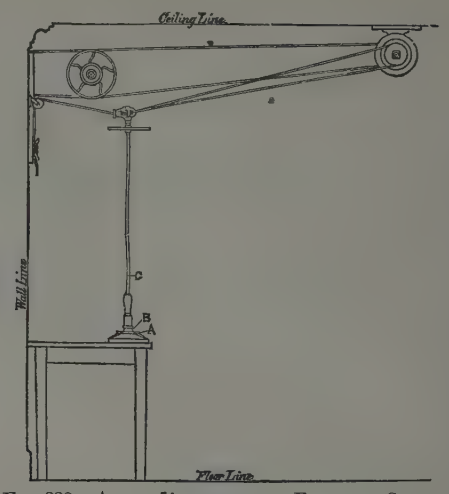


FIG. 228.—AGATE MORTAR WITH FLEXIBLE SHAFT.

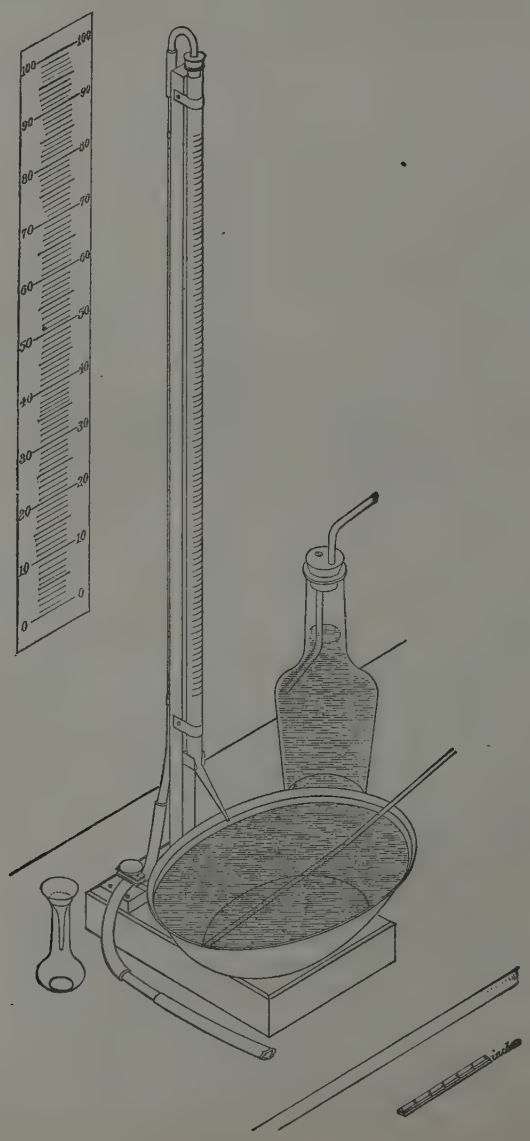


FIG. 229.—BURETTE.

then heated until it was decolorized. Five c.c. of strong HCl were added to decompose any excess of NH_4HSO_3, and the SO_2 driven off by passing CO_2 through the boiling solution. When the last trace of SO_2 was driven off, H_2S was passed through the boiling solution to precipitate any arsenic, the sulphide of arsenic filtered off, the beaker placed in cold water, and, when thoroughly cooled, dilute NH_4HO added until a slight permanent green precipitate of ferrous hydrate remained after stirring. Acetic acid was added until this precipitate dissolved (a few drops should be sufficient), the solution diluted with hot water to about 800 or 900 c.c., and if the precipitate was white, a dilute solution of ferric chloride or bromine water was added until it became red. If it was necessary to add much ferric chloride, a few drops of ammonic acetate were also added to insure the decomposition of all the former salt. The solution was then heated to boiling, boiled a few minutes, filtered rapidly, and washed once with hot water. The filtrate should pass through the filter perfectly clear, and if the precipitate is red, any subsequent cloudiness of the filtrate is of no consequence. If, however, the filtrate passes the filter cloudy, it should be returned to the main portion, a few drops more of ferric chloride added, and the solution again boiled and filtered. The precipitate of ferric phosphate, hydrate, and basic acetate was dissolved in hot dilute HCl (1–1) on the filter, and the large beaker cleared of any adhering precipitate with HCl; the whole solution and washings were received in a small beaker and evaporated nearly to dryness. Five to ten grams of citric acid were dissolved in the least possible quantity of hot water, and filtered into a small beaker, into which were also filtered about 5 c.c. of magnesium mixture, (*a*) and the whole was added to the solution of the ferric phosphate. This solution was then neutralized by NH_4HO and cooled. When perfectly cold, from one-third to one-half its bulk of strong NH_4HO was added, and the solution was stirred until the precipitate of $Mg_2(NH_4)_2P_2O_8$ began to form. After standing for some time, the solution was stirred again, and the stirring was repeated at intervals for an hour. It was allowed to settle over night, filtered on the asbestos felt in Dr. Gooch's pierced crucible, washed with dilute NH_4HO (1–3), dried on the pump, moistened with a drop or two of NH_4NO_3 in ammonia, dried and ignited until the glow passed over the precipitate, cooled in a desiccator and weighed as $Mg_2P_2O_7$. This precipitate was then dissolved in dilute hot HCl, the felt was washed on the pump, and the crucible was heated to redness and reweighed. This weight, unless the precipitate of $Mg_2P_2O_7$ contained SiO_2, agreed perfectly with the original weight. In the latter case, however, the last weight of the crucible was subtracted from the weight of the crucible with the precipitate, to obtain the weight of $Mg_2P_2O_7$. The table A was used for calculating the percentage of P_2O_5, or P, instead of the factors 0.6396 or 0.2793.

TABLE 24—FOR PHOSPHORUS AND PHOSPHORIC ACID.

Mg	P	P_2O_5	Mg	P	P_2O_5	Mg	P	P_2O_5	Mg	P	P_2O_5
1	0.003	0.006	26	0.073	0.166	51	0.142	0.326	76	0.212	0.486
2	0.005	0.013	27	0.075	0.173	52	0.145	0.332	77	0.215	0.492
3	0.008	0.019	28	0.078	0.179	53	0.148	0.339	78	0.218	0.499
4	0.011	0.026	29	0.081	0.185	54	0.151	0.345	79	0.221	0.505
5	0.014	0.032	30	0.084	0.192	55	0.154	0.352	80	0.223	0.512
6	0.017	0.038	31	0.086	0.198	56	0.156	0.358	81	0.226	0.518
7	0.019	0.045	32	0.089	0.204	57	0.159	0.364	82	0.229	0.524
8	0.022	0.051	33	0.092	0.211	58	0.162	0.371	83	0.232	0.531
9	0.025	0.057	34	0.095	0.217	59	0.165	0.377	84	0.235	0.537
10	0.028	0.064	35	0.098	0.224	60	0.167	0.384	85	0.237	0.544
11	0.031	0.070	36	0.100	0.230	61	0.170	0.390	86	0.240	0.550
12	0.033	0.077	37	0.103	0.237	62	0.173	0.396	87	0.243	0.556
13	0.036	0.083	38	0.106	0.243	63	0.176	0.403	88	0.246	0.563
14	0.039	0.089	39	0.109	0.249	64	0.179	0.409	89	0.248	0.569
15	0.042	0.096	40	0.112	0.256	65	0.181	0.416	90	0.251	0.576
16	0.045	0.102	41	0.114	0.262	66	0.184	0.422	91	0.254	0.582
17	0.047	0.108	42	0.117	0.269	67	0.187	0.428	92	0.257	0.588
18	0.050	0.115	43	0.120	0.275	68	0.190	0.434	93	0.259	0.595
19	0.053	0.121	44	0.123	0.281	69	0.193	0.441	94	0.262	0.601
20	0.056	0.128	45	0.126	0.287	70	0.195	0.448	95	0.265	0.607
21	0.059	0.134	46	0.128	0.294	71	0.198	0.454	96	0.268	0.614
22	0.061	0.141	47	0.131	0.300	72	0.201	0.460	97	0.271	0.620
23	0.064	0.147	48	0.134	0.307	73	0.204	0.467	98	0.274	0.627
24	0.067	0.153	49	0.137	0.313	74	0.207	0.473	99	0.276	0.633
25	0.070	0.159	50	0.139	0.319	75	0.209	0.479	100	0.279	0.639

When the amount of $Mg_2(NH_4)_2P_2O_8$ was large it was dissolved, boiled, and reprecipitated, as a small amount of MgO was liable to be carried down mechanically with it. It was found necessary to avoid heating the $Mg_2P_2O_7$ after the glow had passed, as this salt is liable to attack the asbestos slightly at high temperatures, causing a small loss in weight of the felt on the subsequent solution of the precipitate in dilute HCl. For ores containing TiO_2 it was necessary to modify this process in several particulars. It was found that under certain

a Made by dissolving equal weights of $MgCl_2$ and NH_4Cl in the least possible quantity of water, filtering, adding $\frac{1}{8}$ bulk of NH_4HO, stirring occasionally, and allowing it to stand for some days before using.

circumstances phosphoric acid combined with TiO_2 forming a salt (possibly a phospho-titanate) very insoluble in HCl, so that in almost every instance phosphoric acid was found in the insoluble siliceous residue when this contained titanic acid. Also, upon neutralizing the main solution, after adding NH_4HSO_3 in ores containing TiO_2, a fine white precipitate resembling $BaSO_4$ was formed, which usually remained after the subsequent addition of HCl, and was found to consist of TiO_2 with some P_2O_5. If, after dissolving the precipitate of ferric phosphate, etc., thrown down by ammonic acetate, the solution was allowed to run to dryness, there was found after re-solution in HCl, a granular white or yellowish residue, absolutely insoluble in HCl, which consisted essentially of TiO_2 and P_2O_5. This reaction affords a very delicate test for TiO_2, for if the residue obtained in this latter case be collected on a small filter, dried, ignited, and fused with Na_2CO_3 and the fusion treated with hot water, a residue of $NaTiO_3$ will remain, which is insoluble in water. This residue, collected on a small filter, dissolved in a little hot dilute HCl and treated with Zn in a test-tube, gives the very characteristic violet color due to Ti_2O_3.

When TiO_2 was found it was necessary to fuse the insoluble silicious residue, the residue left in the filter from the solution of the precipitate by ammonic acetate, and the residue left from the re-solution of this latter after it had run to dryness, with Na_2CO_3. The fused mass was treated with hot water and filtered; the filtrate containing, besides silica and alumina and sodic carbonate, all the P_2O_5, while the TiO_2 remained on the filter as sodic titanate, insoluble in water. Potassium salts should not be used, as potassic titanate is decomposed by water. The filtrate was acidulated with HCl evaporated to dryness, dissolved in water with a little HCl, filtered, a few drops of solution of Fe_2Cl_6 added, and the ferric phosphate precipitated by ammonic acetate. This precipitate was filtered, washed, dissolved in HCl, and the P_2O_5 was determined by magnesium mixture as usual.

SULPHUR AND IRON.

One gram of ore was fused with 10–12 grams of Na_2CO_3 and a little KNO_3, the fused mass was run well up on the sides of the crucible and the crucible was chilled. The mass was then detached from the crucible and transferred to a tall beaker, or the crucible with its contents was placed in the beaker and treated with boiling water. When the fused mass was entirely disintegrated (the crucible, if placed in the beaker, having been washed off and removed) the ferric oxide was allowed to settle. If the solution was colored by alkaline manganate a few drops of alcohol were added and the solution was allowed to stand until the color disappeared. If the solution after the disappearance of the color due to the manganate was yellow, it was an indication of the presence of Cr_2O_3 in the ore. It was then decanted through a filter and washed twice with hot water by decantation.

The filter was washed once or twice with hot water, and the filtrate was acidulated with HCl evaporated to dryness, redissolved in hot water with a few drops of HCl, filtered from the SiO_2 and the sulphuric acid precipitated by $BaCl_2$ in the boiling filtrate. After standing over night in a warm place the $BaSO_4$ was filtered on the felt, washed thoroughly with hot water (and ammonic acetate, if it was large), and weighed as $BaSO_4$, which, multiplied by 0.1373, gave the S.

The crucible in which the fusion was made was treated with HCl, and when the adhering Fe_2O_3 was dissolved a little hot water was added and the whole was poured on the filter to dissolve any Fe_2O_3 which might have been in suspension in the solution of the fused mass. This was allowed to run into the beaker containing the Fe_2O_3, the crucible was rinsed, and the filter was washed with hot water. The whole was evaporated to dryness to render SiO_2 insoluble, redissolved in HCl, and transferred to a small flask of about 50 c.c. capacity. A small funnel was put in the neck of the flask and 3 grams of granulated zinc in small lumps were added carefully to the solution. By heating the solution and adding a few drops of HCl from time to time, the ferric chloride was soon reduced to ferrous, which was shown by the solution becoming colorless. After washing down the neck of the flask and the funnel with a fine jet of water, if the addition of a few drops of HCl failed to impart any color to the solution, the reduction was considered complete. Fifteen c.c. of dilute H_2SO_4 (1–1) were added, little by little, to the solution, and when the zinc had all dissolved, the neck of the flask and the funnel were carefully washed down and the flask was filled nearly to the top with hot water. The flask was then placed in cold water, and when the solution was thoroughly cooled it was washed out into an oblong white dish of about 1,500 c.c. capacity and diluted to about one liter. A solution of permanganate of potassa was run in from a burette the representation of which is given in Fig. 229.

This form of burette, the invention of Mr. Thomas H. Garrett, is the most satisfactory one I have ever used. The solution of permanganate was carefully standardized by means of ferric chloride of known strength, made by dissolving wrought iron of known composition in HNO_3, driving off the nitric acid by repeated evaporations with HCl, diluting, filtering into a clean glass-stoppered bottle, and determining the Fe_2O_3 gravimetrically in a weighed amount of the solution. The strength of the ferric-chloride solution being thus accurately known, a portion was weighed out into one of the little flasks previously mentioned, reduced with zinc, sulphuric acid added, and the strength of the permanganate solution determined by titration. The amount of the solution necessary to color 3 grams of zinc treated with HCl and H_2SO_4, and diluted to the same volume as the solution of the ore, was subtracted before calculating the value of the permanganate solution, and also from the amount of permanganate solution required for the ore before calculating the percentage of iron. By using H_2SO_4 in addition to the HCl, as

described above, it was found that the end reaction with potassic permanganate was as sharp as if no HCl was used, and the results obtained were in all cases as accurate as could be desired. For many ores it was possible to dissolve the finely-ground sample directly in the flask in HCl without previous fusion, but for those containing ferrous silicates, or pyrites, it was generally necessary to resort to fusion for the accurate determination of the total Fe.

SILICA, FERRIC OXIDE, ALUMINA, MANGANESE, LIME, AND MAGNESIA.

One gram was dissolved in HCl, evaporated to dryness, redissolved in dilute HCl, and evaporated a second time to render the silica insoluble. It was then redissolved in HCl and water (1–3), filtered on a small ashless filter, washed, dried, ignited, and weighed as insoluble siliceous matter. This was fused with five times its weight of dry Na_2CO_3, treated with hot water, and washed into a platinum dish, the crucible treated with acid and carefully rinsed into the dish, the whole acidulated with HCl, evaporated to dryness, treated with water and a little HCl, and evaporated again to dryness. The mass was then treated with HCl and water (1–5) heated to boiling, and filtered on a small ashless filter. The filter was dried, ignited, and weighed. The silica was treated in the crucible with HFl (*a*) and H_2SO_4, evaporated to dryness, ignited, and weighed. The difference between this and the weight of the precipitate was SiO_2. Any residue obtained by the treatment with HFl and H_2SO_4 was examined. It might consist of $BaSO_4$ or TiO_2, if either of these existed in the ore, or of a little alumina or ferric oxide, or of a small amount of Na_2SO_4 if the silica was not carefully washed. The filtrate from the silica was treated in a platinum dish with NH_4HO, boiled until it smelled but faintly of NH_3, filtered, washed, dried, ignited, and weighed as Al_2O_3, with or without a tinge of Fe_2O_3. To the filtrate, ammonic oxalate was added, the solution was boiled and allowed to stand over night, filtered, washed, and ignited at a high temperature and weighed as CaO.

This filtrate was evaporated down, $NaNH_4HPO_4$ was added, and the solution was well stirred to precipitate the $Mg_2(NH_4)_2P_2O_8$. After standing over night it was filtered, washed, ignited, and weighed as $Mg_2P_2O_7$. Whence 111 : 40=weight of $Mg_2P_2O_7$: weight of MgO. The sum of the weights of the SiO_2, Al_2O_3, CaO, and MgO should about equal that of the insoluble siliceous matter. When there was a deficiency, alkalies were looked for in another portion. If there was an excess, and the precipitate Al_2O_3 was red, FeO in insoluble matter was determined. (See p. 515.)

The filtrate from the insoluble siliceous matter was nearly neutralized with Na_2CO_3 solution, 2 grams of sodic acetate were added, and the whole, after being diluted to about 700 c.c. with hot water, was boiled and the precipitated ferric oxide, etc., was filtered on a washed filter. The precipitate was washed two or three times on the filter and then transferred back to the beaker with a platinum spatula, the filter was washed with HCl and finally with water, the whole being received in the beaker with the mass of the precipitate. Sufficient acid was added to dissolve the precipitate, and the operation was repeated, the filtrates being added together. The solution of the precipitated ferric oxide, etc., was evaporated to dryness to render insoluble any SiO_2 from the reagents; redissolved in dilute acid and filtered into a large platinum dish, the solution was boiled, NH_4HO was added, and the precipitate was collected on an ashless filter, washed thoroughly on the pump with hot water, dried, ignited (finally over the blast), and weighed as $Fe_2O_3Al_2O_3P_2O_5$. The filtrates from the acetate precipitations were evaporated down to about 300 c.c., 2 or 3 grams of sodic acetate were added, the solution was heated to boiling, and H_2S was passed through to precipitate any Cu, Ni, Co, and Zn.

The precipitate by H_2S was filtered off, and after all smell of H_2S had been boiled off, bromine water was added to the solution. When the precipitated manganic oxide had collected at a gentle heat, and while the solution was still colored by bromine, it was boiled until colorless, filtered, washed several times, and the manganic oxide was dissolved on the filter in HCl, with the addition of solution of H_2SO_3, which caused its very rapid solution. This solution was evaporated to dryness, redissolved in HCl and water, a slight excess of NH_4HO was added, nearly all smell of NH_3 was boiled off, the solution was filtered, any slight precipitate of Fe_2O_3, etc., was redissolved, and reprecipitated and filtered as before. The filtrates were added together and excess of $Na(NH_4)HPO_4$ was added with enough HCl to render the solution decidedly acid, and after boiling for some time, an excess of NH_4HO was added to precipitate the $Mn_2(NH_4)_2P_2O_8$. This was boiled until the precipitate became crystalline and the solution smelled but slightly of NH_3, when it was filtered, washed with cold water, ignited, and weighed as $Mn_2P_2O_7$, which, multiplied by 0.5, gave MnO.

To the filtrate, from the precipitate of manganic oxide by bromine, was added the ammoniacal filtrate from the final precipitation of the Fe_2O_3, Al_2O_3, and P_2O_5; the whole was evaporated down to about 400 c.c., and the lime and magnesia were precipitated as described in the analysis of the insoluble siliceous matter. There were several sources of error which it was found very necessary to guard against in the above analysis, namely, the contamination of the distilled water by silica when it was boiled in glass, the strong action of ammoniacal solutions on the beakers, and the presence of silica, alumina, ferric oxide, lime, and magnesia in many reagents, and especially in sodic carbonate. Distilled water which had been heated over night in a Bohemian flask on the sand-bath was found to

a The HFl was redistilled with the addition of a little H_2SO_4 and potassic permanganate from a platinum still and collected in a platinum bottle, as the crude HFl always contained ferric oxide, beside various sulphur compounds.

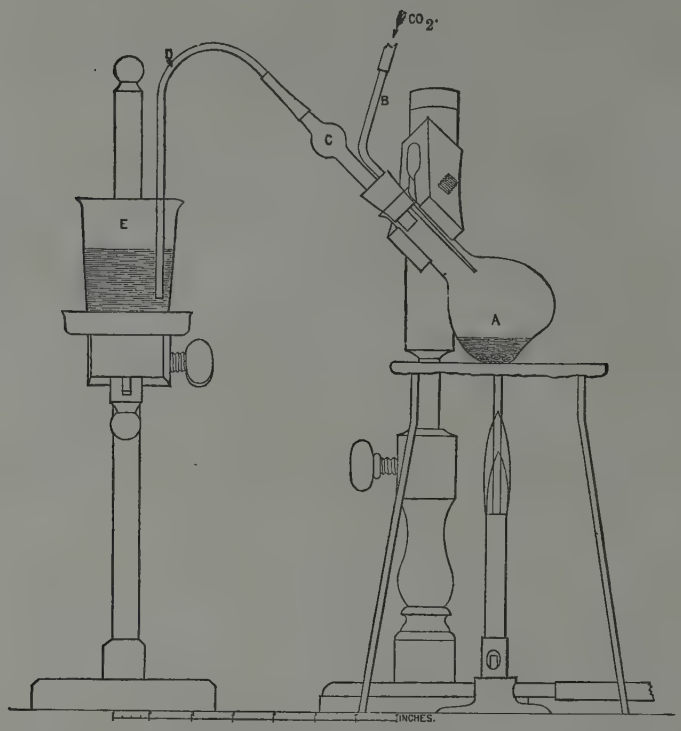


FIG. 230.—APPARATUS FOR DETERMINATION OF FeO SOLUBLE IN HCl.

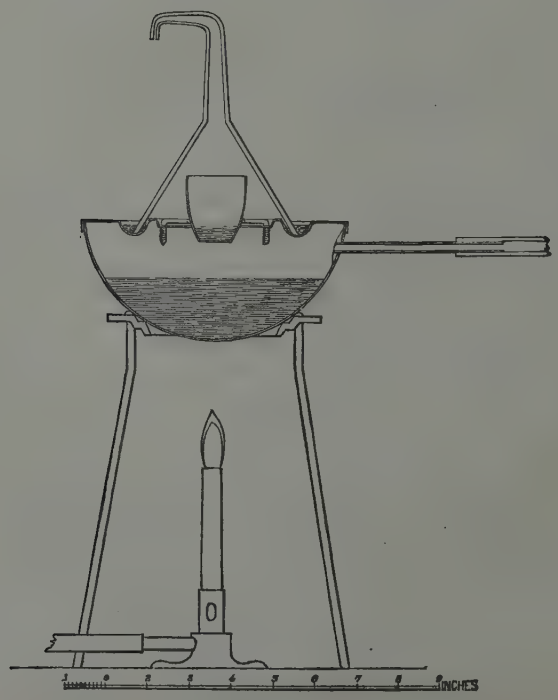


FIG. 231.—APPARATUS FOR DETERMINATION OF FeO IN INSOLUBLE RESIDUE.

contain 52 milligrams of solid residue to the liter, 26 milligrams of which was SiO_2; and Fe_2O_3 precipitated from a solution to which water boiled in a flask from 2 to 6 hours had been added, contained after ignition as much as 3 per cent. of SiO_2. To avoid this, tin-lined copper flasks were used for heating distilled water, and to avoid the error due to the action of ammonia salts and ammoniacal solutions on the beakers, all the precipitations and evaporations were made in platinum. We were fortunate enough to obtain some remarkably pure sodic carbonate containing only 2 milligrams of SiO_2, $1\frac{1}{2}$ milligrams of Al_2O_3, 2 milligrams of CaO, and 2 milligrams of MgO to the 100 grams, from Messrs. Powers & Weightman, Philadelphia.

NICKEL, COBALT, AND ZINC.

Three grams of ore were treated as if for the determination of manganese and the sulphides of Cu, Ni, Co, Zn were precipitated from the boiling solution of the acetates by H_2S. This precipitate was collected on a small filter, washed with H_2S water containing a little acetic acid, dried, ignited in a porcelain crucible, and transferred to a small beaker. It was then treated with HCl and a little HNO_3, evaporated to dryness, redissolved in HCl, diluted, boiled, and the Cu was precipitated by H_2S. The CuS was filtered off and washed with hot water, the filtrate containing the Co, Ni, and Zn was evaporated to dryness, redissolved in a few drops of water containing not more than two or three drops of HCl, and an excess of K_2NO_2 acidulated with acetic acid added. After standing for a day or two the potassic cobaltic nitrite was filtered off, washed once or twice with a strong solution of potassic acetate, and then, after removing the filtrate, with alcohol to displace the alkaline salts. The precipitate was then ignited very carefully in a porcelain crucible, treated with H_2SO_4 to decompose all the nitrite, made alkaline with NH_4HO, filtered, and the Co was precipitated by the battery; or the ignited precipitate was dissolved in a few drops of HCl, transferred to a small beaker, diluted, and any Al_2O_3 and Fe_2O_3 present was precipitated by boiling for several hours with an excess of sodic acetate. The precipitate of Fe_2O_3 and Al_2O_3 was filtered off, the filtrate was made alkaline with ammonia, and the cobalt was precipitated as sulphide by NH_4HS. The precipitate was allowed to settle, filtered off on a small ashless filter, washed, dried, ignited, and weighed as Co_2S, or treated with H_2SO_4 and zinc and weighed as CoS_4, which, multiplied by 0.4872, gave CoO.

The filtrate from the potassic cobaltic nitrite was acidulated strongly with HCl and heated to decompose all the nitrite, and the NiO was precipitated by an excess of NaHO or KHO, filtered, and the filtrate was tested for ZnO with NH_4HS. If any ZnS was found, the NiO was redissolved and precipitated as before, filtered, and the filtrate and washings were added to the first filtrate, the ZnS was allowed to settle, filtered, washed with water containing NH_4HS, redissolved in HCl, and evaporated to dryness. This was treated with dilute HCl, filtered, and the zinc was precipitated by solution of Na_2CO_3, filtered, washed, dried, ignited, and weighed as ZnO.

The precipitate of NiO was dissolved on the filter in HCl, the filtrate run to dryness with H_2SO_4, diluted, excess of NH_4HO was added, filtered, and the Ni precipitated by the battery; or the HCl solution was evaporated to dryness, dissolved in a drop or two of HCl, diluted, and boiled with an excess of sodic acetate. Any precipitate of Al_2O_3, etc., was filtered off, excess of NH_4HS was added, then an excess of acetic acid and H_2S was passed through the boiling solution. The precipitated NiS and S were collected on a small ashless filter, dried, ignited, heated with a little ammonic carbonate, and weighed as Ni_2S.

DETERMINATION OF FERROUS OXIDE.

One gram of finely-ground ore was weighed into a flask A (Fig. 230), of about 100 c.c. capacity, fitted with a rubber stopper, through which passed two glass tubes, as shown in the cut. Dry CO_2 was passed in through the tube B, to expel the air through the tubes C and D, the latter dipping beneath the surface of the water in the beaker E, and when this was accomplished the stopper was removed, 15 c.c. of strong HCl was quickly poured in, the stopper was replaced, and the ore was dissolved with the aid of heat, the current of CO_2 being continued uninterruptedly. When the solution of the ore was accomplished the source of heat was removed, and the current of CO_2 being temporarily stopped, the water in the beaker B was allowed to run back into the flask A until the latter was nearly filled, when the current of CO_2 was turned on again and allowed to continue until the solution in the flask was thoroughly cooled. This was accomplished by removing the tripod C, placing a dish nearly filled with cold water under the flask, and replacing the tripod. The solution was then washed out into the dish used for titrating, into which 3 grams of zinc dissolved in 15 c.c. of the dilute H_2SO_4 (1–1) were previously poured, and the whole was diluted to 1 liter. The amount of ferrous oxide was then determined by the potassic permanganate solution. The amount of solution required to color about 1 gram of ferric chloride diluted to the same bulk and containing the same amount of H_2SO_4 was subtracted from the amount required for the titration before calculating the amount of ferrous oxide.

FERROUS OXIDE IN INSOLUBLE SILICEOUS MATTER.

When the insoluble siliceous matter contained iron in the ferrous condition, for instance, in the form of epidote, 1 gram was treated with HCl diluted, and the insoluble matter was collected on the felt in a pierced crucible, carefully dried, transferred with the felt to an ordinary platinum crucible, and treated, in the apparatus of Fig. 231,

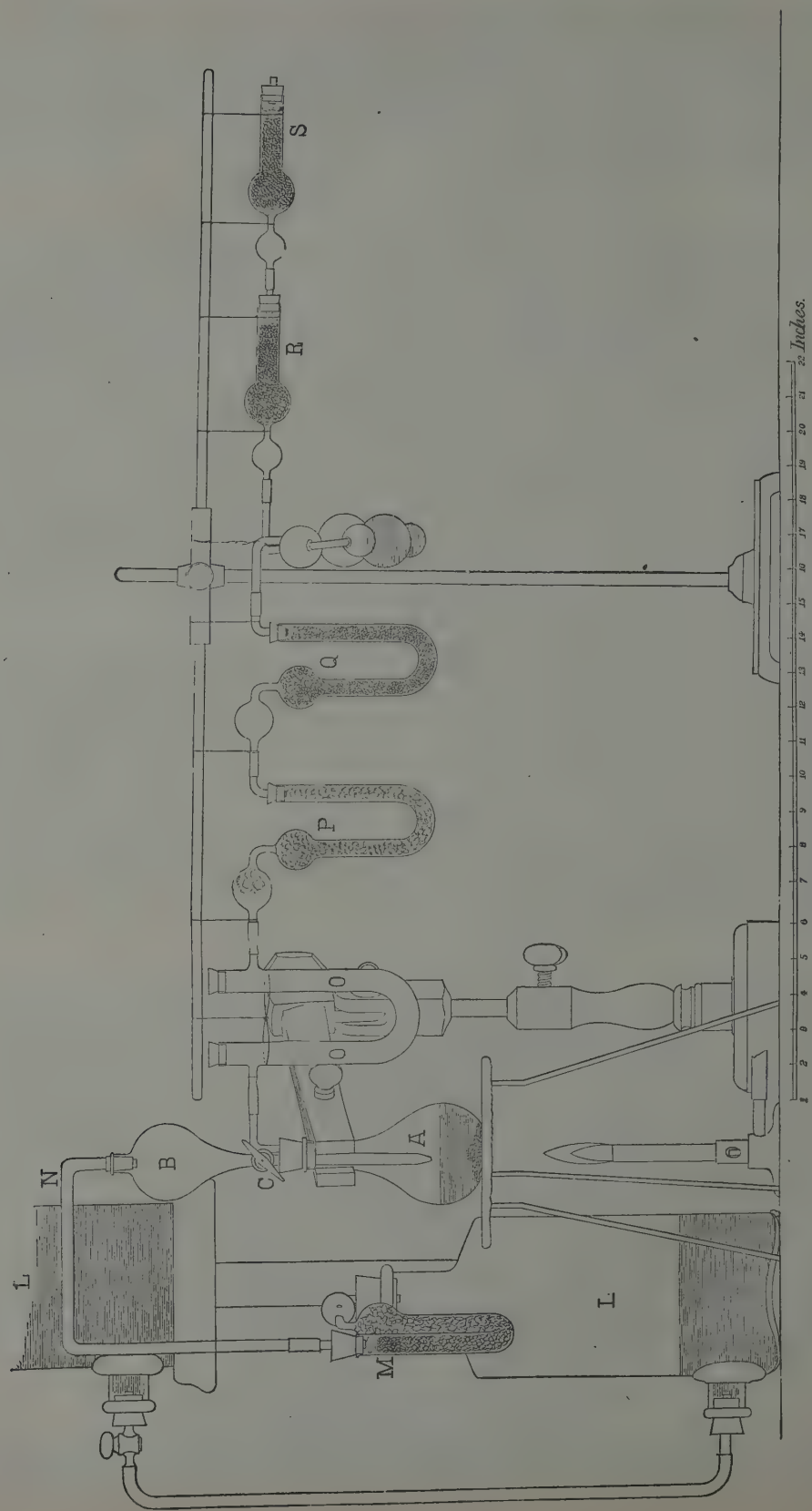


FIG. 232.—APPARATUS FOR DETERMINATION OF CO_2 IN IRON ORES.

with HFl and HCl in a current of CO_2. When entirely decomposed it was allowed to cool, the current of CO_2 being kept up, and then transferred quickly to a dish containing about 1 liter of water and 15 c.c. of the dilute H_2SO_4 and zinc, the crucible was washed out, and the amount of FeO was determined by the standard solution of potassic permaganate.

SULPHURIC ACID.

Sulphuric acid may exist in the ore in the form of baric sulphate, calcic sulphate, or as sulphates of iron, etc., formed in the roasting or weathering of an ore containing pyrites. When it existed as baric sulphate it wat found, in the analysis of the insoluble siliceous matter, in the residue remaining after the treatment of the silica with HFl. In this case the residue was fused with Na_2CO_3, treated with hot water and filtered. The filtrate was acidulated with HCl and the sulphuric acid was precipitated by baric chloride and determined as $BaSO_4$, which, multiplied by 0.3433, gave SO_3.

The baric carbonate on the filter was dissolved in dilute HCl, H_2SO_4 was added, and the $BaSO_4$ was finally weighed, which, multiplied by 0.6567, gave BaO. In the other cases 10 grams of the ore finely ground were treated with water containing a little HCl, filtered, the sulphuric acid was precipitated in the filtrate as $BaSO_4$, and the weight was determined with the usual precautions.

ALUMINA.

The total amount of the soluble $Fe_2O_3+Al_2O_3+P_2O_5$ was added to the $Al_2O_3+Fe_2O_3$ found in the insoluble siliceous matter, and from this was subtracted the P_2O_5, which gave the total, $Fe_2O_3+Al_2O_3$. From this was subtracted the Fe_2O_3 found by titration; the difference was Al_2O_3. The accuracy of this result depended, of course, upon that of the volumetric determination of the Fe_2O_3. The comparison of many analyses showed that the error due to this need never exceed a few hundredths of 1 per cent., and no direct method was found to yield results equally accurate or concordant.

CALCULATION OF THE ANALYSIS.

The S in the sulphuric acid found as such was subtracted from the total S; so much as was necessary to form the sulphides of Cu, Ni, Co, Zn, Sb with the amounts of these elements in the ore, and supposed to exist in this condition, was subtracted from this, and the remaining sulphur was calculated to FeS_2. The amount of Fe required for this was calculated to Fe_2O_3, and subtracted from the Fe_2O_3 found by titration. From this was taken the amount of Fe_2O_3 calculated from the FeO found in the determination of ferrous oxide, and the result was the amount of Fe_2O_3 existing in this state in the ore.

CARBONIC ACID.

Three grams of ore were weighed into the flask A of the apparatus (Fig. 232), and the connections were made as there shown; 10 c.c. of strong H_2SO_4 were added to 65 c.c. of water and poured into the bulb-tube B, the stop-cock C having first been closed. After the potash bulb and the drying tube were weighed they were attached to the apparatus, the tube S was filled with fused $CaCl_2$, being added to prevent the drying tube R from absorbing moisture from the atmosphere. The U-tube O was empty. P was filled with pumice saturated with anhydrous $CuSO_4$, and Q with dried $CaCl_2$. When the connections were all proved to be tight, the tube N was fitted into the neck of the bulb-tube with a piece of rubber tubing, and the acid in the bulb was allowed to run into the flask very slowly, and when it was all in, a slow current of air was forced through the apparatus by means of the bottles L L. The air was freed from CO_2 by potassic hydrate in the tube M. As soon as the current of air was started, the flask A was heated gradually, and finally the solution was boiled until the bend of the tube O was filled with condensed water. It was then allowed to cool while the current of air was continued. The potash bulb and the drying tube were detached and weighed with the usual precautions; the increase of weight, of course, was the CO_2 due to the carbonates contained in the ore.

WATER AND CARBON IN CARBONACEOUS MATTER.

Many ores besides blackbands contain carbon; for instance, several ores from New Jersey contain graphite, and nearly all limonites and magnetites contain carbon in organic matter, probably from the organic acids which originally held the iron in solution. As pyrites was also of common occurrence in such ores, it was necessary to devise some method by which the water of composition and the carbon could be determined in the presence of pyrites. In attempting to determine the water by heating the ore in a current of air, some H_2SO_4 was always formed and driven over into the drying tube, and some organic matter was certain to be dissolved if the ore was treated with acid for the determination of the carbon. It was found by careful experiments that when a carbonate of any kind was fused with potassic anhydrodichromate in excess, the CO_2 was all expelled together with any water present, while pyrites treated in the same way was oxidized with formation of potassic sulphate, which was not decomposed even at a bright red heat.

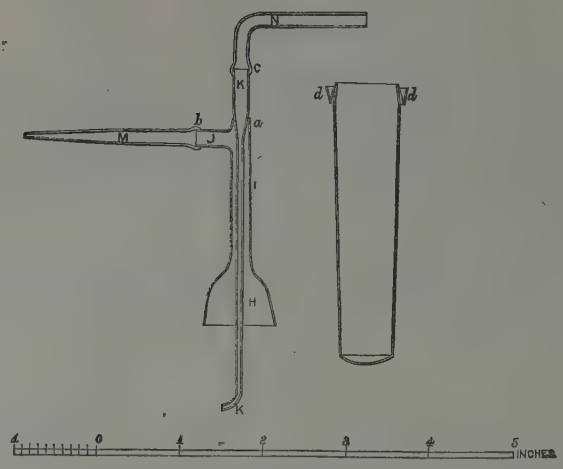


FIG. 233.

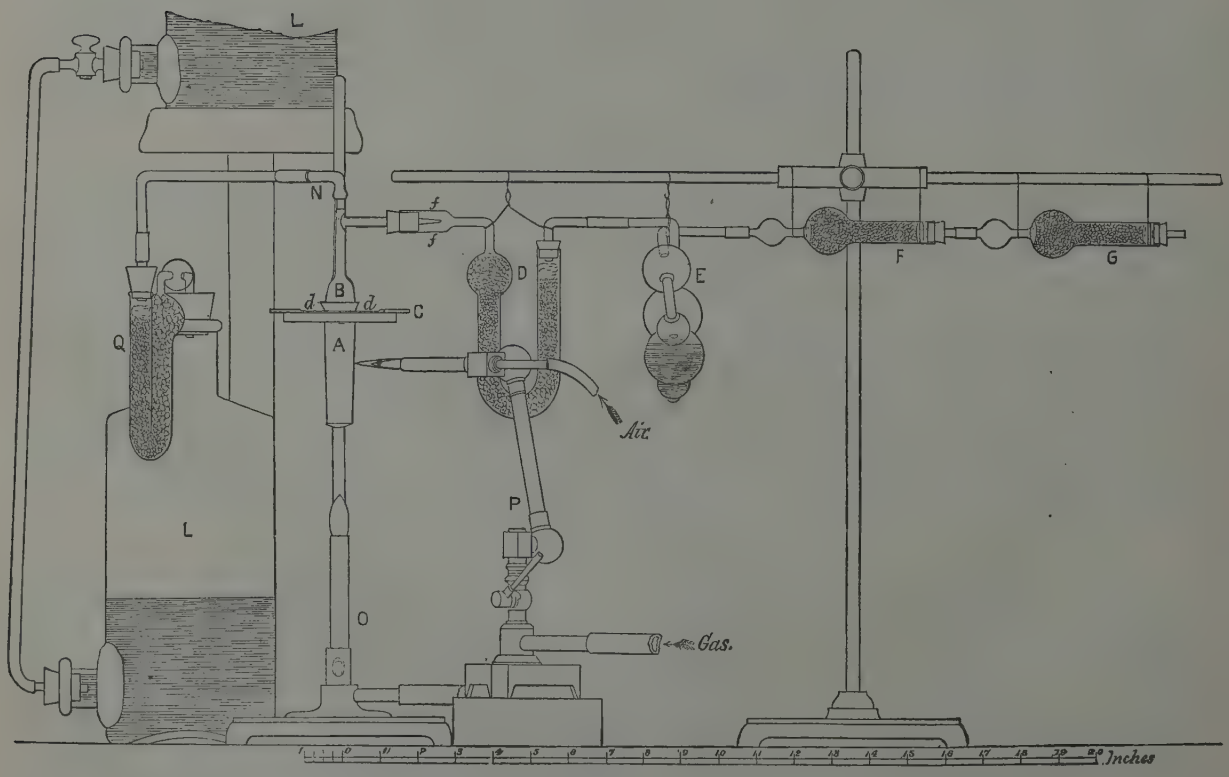


FIG. 234.—APPARATUS FOR DETERMINATION OF WATER AND CARBONACEOUS MATTER IN IRON ORES.

A very practical and easy way to apply this in the treatment of ores was afforded by the use of Dr. Gooch's tubulated crucible (*a*, Fig. 233), and the process was as follows:

For ores containing much water or carbonic acid, 1 gram, and for others 3 grams, were weighed into the crucible, A of Fig. 234, and carefully mixed, by means of a rod or wire, with 7 grams of $K_2CrO_4CrO_3$, which had been previously fused and powdered, the cap B was adjusted, and the whole was placed in the air-bath and heated to 100° for a short time. The crucible was then placed on the platinum triangle C and connected by means of a cork with the weighed tube D containing dried $CaCl_2$, and the weighed potash bulb E and drying-tube F were attached, the latter guarded by the $CaCl_2$ tube G, as can be seen in the sketch.

The cap for the crucible consists of a conical cover, H, drawn out vertically into a tube, I, into which is burned a horizontal tube, J, of the same diameter. Through the top of the tube I passes the tube K to a distance of ½ inch below the bottom of the cap, the end being slightly bent; K is burned into I at its point of entry, *a*, sealing I at this point. A straight glass tube, M, drawn tapering, is fused to the platinum tube J at *b*, and another piece, N, is bent at a right angle to the platinum tube K at *c*. A piece of rubber tubing closed with a piece of glass rod at one end was drawn over the end of the tube N, the space around the cap in the flange *d* was filled with small pieces of neutral anhydrous sodic tungstate, which were fused by means of a blow-pipe flame, making an air-tight joint. The mixture in the crucible was kept cool during this operation by dipping the end in a beaker of cold water. The expansion of the air in the apparatus during the heating caused it to bubble through the potash bulb, and the reflux of the solution in the bulb as the apparatus cooled was a good index of the tightness of the joints. When the joints were shown to be all tight the cap was removed from N and the bottle L was connected with N, as shown in the sketch. A slow current of air, freed from CO_2 and water by passing through the tube Q, containing KHO and $CaCl_2$, was then started through the apparatus, and the crucible was heated very gradually and cautiously by the burner O. As the steam was gradually driven into the drying-tube it was not allowed to condense at *f*, but was driven forward into the $CaCl_2$ by the heat of a small alcohol lamp applied to the drying-tube at this point. When the greater part of the water had been thus driven over, the crucible was heated by a horizontal flame from the blast-lamp P above the level of the mixture, to prevent the latter from frothing up and stopping the end of the tube K. The bottom of the crucible was gradually heated to a dull red and allowed to remain at this temperature for about 15 minutes, when the lamps were turned out and the whole was allowed to cool in the current of dried air from the bottle L. The tubes were then reweighed; the increase in the weight of D was the weight of the water of composition in the ore, and that of the potash bulb and drying-tube the weight of the total CO_2. This latter, of course, was the sum of the CO_2 due to the carbon of the carbonaceous matter or graphite, and of that due to the CO_2 in the carbonates. The amount of the latter (previously determined) was subtracted from the total CO_2, and the difference, multiplied by 0.2626, gave the carbon in carbonaceous matter, or the graphite.

ALKALIES.

The alkalies were generally confined to the insoluble siliceous matter in the ores, but were occasionally found in the portion soluble in HCl. In the former case 5 or 10 grams of the ore were digested in HCl until only the silicates remained undissolved, diluted, and filtered. The insoluble residue was washed, dried, ignited, and treated in the crucible with HFl and H_2SO_4 until it was entirely decomposed; it was then evaporated down until all the HFl and nearly all the H_2SO_4 volatilized. It was then treated with hot water and a little HCl, if necessary; the clear solution was transferred to a small platinum dish, the Al_2O_3 and Fe_2O_3 were precipitated by NH_4HO, and the solution was boiled until nearly all NH_3 was driven off. It was then filtered into another platinum dish, evaporated to dryness, and heated until all the ammonium salts were volatilized. The residue was treated with a little water, a few drops of ammonic oxalate and excess of NH_4HO, and the solution was boiled and filtered. The filtrate was evaporated to dryness and the residue was heated to dull redness. It was then treated with water, filtered, and an excess of baric hydrate (*b*) was added to precipitate the sulphuric acid and magnesia. The solution was boiled and filtered from the $BaSO_4$, and the filtrate was evaporated to dryness, after the addition of a little ammonic carbonate and hydrate. The residue was treated with a little water, filtered to get rid of the $BaCO_3$, and the filtrate was evaporated to dryness and heated carefully to volatilize any ammonium salts. The residue was treated with water, filtered into a small weighed platinum dish; the filtrate was acidulated with HCl, evaporated to dryness, heated carefully to a very low red, and weighed as quickly as possible as alkaline chlorides. (*c*) The alkaline chlorides were then dissolved in water, any residue was filtered off, weighed, and its weight subtracted from the weight of the chlorides, an excess of platinic chloride was added, and the solution was evaporated on the water-bath until the sirupy liquid solidified on cooling. The residue was treated with alcohol 95 per cent., filtered on the felt, washed with 95 per cent. alcohol, dried at 120° C., and weighed as K_2PtCl_6, which, multiplied by 0.1931, gave K_2O. The weight of the K_2PtCl_6, multiplied by 0.3056, to reduce to KCl, was subtracted from the weight of the alkaline chlorides, and the difference (NaCl), multiplied by 0.5299, gave Na_2O.

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a Am. Chem. Jour., vol. ii, p 247. Chem. News, vol. xlii, p. 326.

b Made by treating ordinary $BaCo_3$ with tolerably strong HNO_3, and washing the baric nitrate with HNO_3. The baric nitrate was dried and fused until all the HNO_3 was driven off.

c Mixed with a little $MgCl_2$.

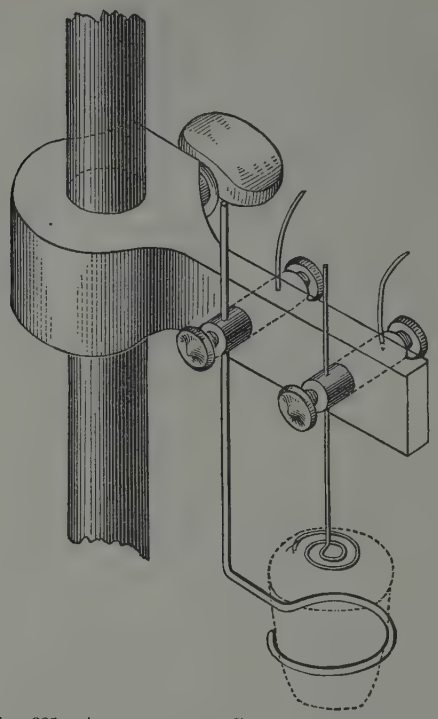

FIG. 235.—APPARATUS FOR COPPER DETERMINATION.

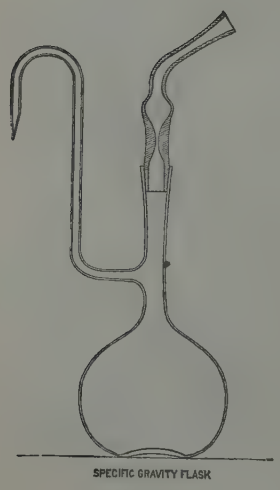

FIG. 236.

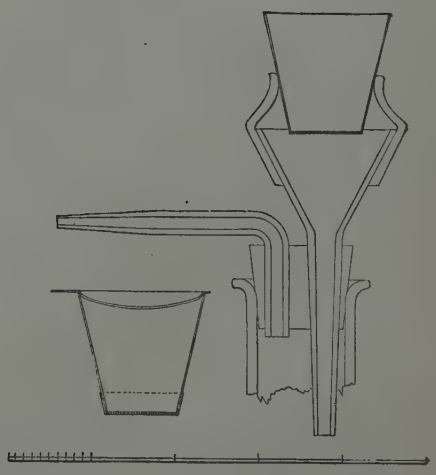

FIG. 237.—PERFORATED CRUCIBLE.

The filtrate from the K_2PtCl_6 was evaporated to dryness in a platinum dish, with the addition of a little oxalic acid to decompose all the platinic chloride, the residue was treated with water, filtered, and any MgO was precipitated by microcosmic salt and weighed as $Mg_2P_2O_7$, which, multiplied by 0.428, gave the amount of MgCl to be subtracted from the weight of chlorides to get the amount of alkaline chlorides.

For the estimation of alkalies in the portion of the ore soluble in HCl, 1 gram was treated with HCl, diluted, filtered into a platinum dish heated to boiling; a slight excess of NH_4HO was added, and the whole was evaporated to dryness in the air-bath to render the Fe_2O_3 very granular and easy to wash. It was then treated with water, a drop or two of NH_4HO was added, and the Fe_2O_3, etc., filtered off and washed. The filtrate, after the addition of a drop or two of H_2SO_4, was evaporated to dryness, and the ammoniacal salts were driven off by ignition. The residue was treated with water, a little ammonic oxalate was added to precipitate the lime, and the alkalies were determined, as in the former case, after the precipitation of the calcic oxalate.

COPPER, LEAD, ARSENIC, AND ANTIMONY.

Ten grams of the very finely-ground ore were treated with HCl, with the addition $KClO_3$, until only the siliceous residue remained unacted upon. It was then diluted, filtered, reduced with ammonic sulphite, all the excess of SO_2 was boiled off, and H_2S was passed through to saturation. The precipitate was allowed to settle in a warm place, and when the smell of H_2S had nearly passed off it was filtered on the pump, washed, and treated on the filter with KHS, to dissolve out the sulphides of arsenic and antimony. The filter containing the sulphides of copper and lead was dried and ignited in a porcelain crucible. The ignited sulphides were transferred to a small beaker and treated with HCl and HNO_3, excess of H_2SO_4 added, and the whole was evaporated down until SO_3 began to volatilize. Water was then added, and, if any $PbSO_4$ separated out, an equal bulk of alcohol, and the whole was allowed to stand some hours, when the $PbSO_4$ was filtered off, dissolved in basic ammonic tartrate or acetate, and the PbS, precipitated by H_2S, was filtered, washed, and ignited. It was treated in the crucible (porcelain) with HNO_3 and H_2SO_4, and finally ignited and weighed as $PbSO_4$, which, multiplied by 0.6832, gave Pb. The solution containing the copper was evaporated down to drive off the alcohol, washed out into a platinum crucible, and the copper was precipitated on the crucible by the battery in the apparatus shown in Fig. 235, washed with water and alcohol, and weighed as Cu.

The KHS solution, containing the sulphides of arsenic and antimony, was acidulated with HCl and allowed to stand in a warm place until the sulphides and free sulphur had collected and the solution smelled but faintly of H_2S. It was then filtered on the felt, and the precipitate, if it contained much free sulphur, was treated with carbon disulphide, transferred with the felt to a small beaker and treated with HCL and $KClO_3$, or aqua regia, which dissolved the arsenic and antimony very readily.

A little tartaric acid was added to keep the Sb in solution, the whole was diluted and filtered, excess of NH_4HO was added, and then magnesium mixture, and the arsenic precipitated as ammonic-magnesic arsenate, with the same precautions that were used in the precipitation of P_2O_5. The precipitate was filtered on the felt, washed with dilute NH_4HO, dried at 110° C., and weighed as $Mg_2(NH_4)_2As_2O_8H_2O$.

It was then heated, very gradually at first, and finally to a full red, and weighed as $Mg_2As_2O_7$. The first weight obtained, multiplied by 0.3947, and the second by 0.4839, gave As. If the heat was applied carefully and slowly enough at first the latter result was most apt to be the correct one. The filtrate which contained the antimony was acidulated with HCl and the Sb was precipitated by H_2S with the usual precautions, filtered on a small disk of paper on the bottom of the perforated crucible, dried, and the precipitate and paper were treated in a porcelain crucible with fuming nitric acid, evaporated to dryness, ignited, and weighed as Sb_2O_4, which, multiplied by 0.7922, gave Sb.

TITANIC ACID.

As titanic acid was found to interfere with the determination of phosphoric acid, so the latter was found in many cases to absolutely prevent the precipitation of the former. When the ore contained only a small amount of TiO_2, 5 grams were treated with HCl, evaporated to dryness, redissolved in dilute HCl, filtered, the insoluble residue dried, ignited, and treated in the crucible with HFl and H_2SO_4. The solution in the crucible was evaporated down until all the HFl and H_2SO_4 were driven off, ignited, and the residue was fused with Na_2CO_3. The fused mass was treated with hot water, which dissolved the sodic phosphate, aluminate, and excess of sodic carbonate, (*a*) leaving insoluble the sodic titanate and any ferric oxide, calcic carbonate, baric carbonate, etc. The insoluble portion was filtered off, washed, dried, and put aside to be added to the TiO_2 in the soluble portion. The filtrate obtained after the first treatment of the ore with HCl, which contained the great mass of the iron, with the TiO_2, which, dissolved with it, was deoxodized by ammonic sulphite, the excess of SO_2 driven off, and the ferric phosphate, titanate, and small excess of ferric oxide were precipitated by ammonic acetate exactly as in the estimation of the P_2O_5. This precipitate was filtered off, washed, dried, and fused with Na_2CO_3, the fused mass

a Any tungsten in the ore would be in this solution as sodic tungstate.

was treated with water, filtered, and the insoluble portion, containing Fe_2O_3 and sodic titanate, was washed and dried. The two filters containing the sodic titanate were separated as carefully as possible from the adhering precipitates, ignited in a platinum crucible, the precipitates were added, and the whole was fused at a low heat with 15–20 times the weight of acid potassic sulphate. The heat was gradually increased to a dull red and kept at this point until the fusion was perfectly clear and of a reddish-brown color. It was then cooled and treated with a large excess of cold water containing a few drops of H_2SO_4, with constant stirring until nothing remained undissolved except, perhaps, a little SiO_2. It was then filtered, washed with cold water, the filtrate was diluted to about 500 c.c., and boiled in a large platinum dish or beaker, with the constant addition of strong aqueous solution of sulphurous acid until all the TiO_2 was precipitated. The precipitate was allowed to settle, the clear solution was decanted through a filter, the precipitate was boiled up with water, thrown on the filter, and washed with boiling water, dried, ignited cautiously, and weighed as TiO_2. The filtrate was boiled again with the addition of sulphurous acid, and any further precipitate filtered off and added to the first. It was found that when the solution was kept at the boiling point during the filtration, and the precipitate washed with boiling water, there was no tendency to pass the filter; whereas if the solution was allowed to get cold, the filtrate was nearly always cloudy. To prevent the precipitation of ferric oxide with the TiO_2, it was necessary to keep an excess of SO_2 in the solution; but, if in spite of this precaution the ignited TiO_2 was colored with Fe_2O_3, it was fused again with $KHSO_4$ and reprecipitated. In the analysis of ores containing much TiO_2 it was preferable to fuse the ore at once with Na_2CO_3, treat with water, filter, wash and dry the residue, separate and burn the filter, fuse the residue and filter-ash with $KHSO_4$ and determine the TiO_2 as before.

DETERMINATION OF SPECIFIC GRAVITY.

A great many experiments were made both on lumps and on powdered ore, and it was decided that in commercial samples good results could be obtained only by using the powdered material. The work was done, and the flask herein described was made by Mr. James Hogarth. About 20 grams of the powdered sample were weighed out and transferred to the specific-gravity flask, the construction of which is shown in Fig. 236. This flask was made with the view of overcoming two difficulties which occur in using the common flask, viz, the expansion and overflow consequent on transferring the flask at 60° F. to the higher temperature of the balance-case, and the necessity for waiting until the finely-divided mineral had settled before the stopper could be inserted without loss of material. These ends were successfully met by melting on a capillary tubulus to the lower part of the neck and grinding in a stopper having a small bulb above the capillary, to allow for expansion.

Having transferred the weighed quantity of ore to the flask, enough water was added to cover it, and the temperature was raised almost to the boiling point by placing the flask in a water-bath. To insure complete expulsion of air the flask was now placed under a bell jar connected with the aspirator and allowed to boil for a few moments at the reduced pressure. It was then filled up with water almost to the tubulus, cooled, the stopper was inserted, and by suction it was filled up slightly above the mark on the capillary part of the stopper. When the thermometer was stationary at 60° F. the volume was adjusted by touching the capillary end of the tubulus with blotting-paper, or by bringing a drop of water to it, as the case might require. The flask was then dried, transferred to the balance-case, and, after a sufficient time had elapsed to allow it to take the temperature of the room, weighed.

If W be the weight of ore taken, W′ the weight of ore + water at 60°, and K the weight of the flask + water at 60°, then

$$\text{Sp. gr.} = \frac{W}{W + K - W'}.$$

To obtain K the flask was nearly filled with boiled water and treated exactly as described above.

THE PERFORATED CRUCIBLE.

In processes in which the use of filter-paper is deleterious or inconvenient, filtrations and ignitions have been made with the aid of the asbestos filter devised by Mr. Gooch, which consists essentially of a felt of asbestos deposited upon a perforated surface of platinum. (*a*)

The mode of preparing the filter is as follows: Asbetos of fine, silky, flexible fiber is scraped longitudinally (not cut) to a fine, short down, which is purified by boiling in strong hydrochloric acid and washing by decantation. A platinum crucible, with bottom perforated with numerous fine holes, is fitted to the upturning end of a piece of soft-rubber tubing, the other end of which is stretched over the top of a funnel, as shown in Fig. 237, and the neck of the latter passes through the stopper of a vacuum flask in the usual way.

a For a full description of the process, I refer to Mr. Gooch's original publication in Proceedings of the Amer. Acad. of Science (1878), or Chem. News, xxxvii, 181.

The vacuum pump having been put in action, a little of the prepared asbestos, suspended in water, is poured into the crucible and the pump is attached, when the asbetos at once assumes the condition of a firm, compact layer, which is washed with ease under the pressure of the pump.

After washing the felt, the crucible with the felt adhering is removed from the funnel, ignited, cooled, and weighed as usual; then set again in place in the rubber holder, taking care that the pump is working, and the liquid to be filtered is poured into the crucible. The crucible, felt, and adhering precipitates are, after washing, ingited, or merely dried, as the case demands, with no further care than the nature of the precipitate itself necessitates.

During the ignition of precipitates, it is frequently necessary to prevent the contact of reducing gases with the perforated bottom; and this is accomplished by placing the crucible either upon a platinum crucible cover or within a second crucible, or better, by using a form of crucible which is conical in shape and provided with a cap, removable at pleasure, to cover the bottom during ignitions. (*a*) When a larger filtering surface than the bottom of a crucible affords is needed, a cone of platinum, perforated and fitted to a rubber seat, is substituted for the crucible.

SKETCH OF THE VARIOUS METHODS PROPOSED FOR THE DETERMINATION OF PHOSPHORIC ACID, AND DISCUSSION OF THE METHODS IN GENERAL USE AT THE PRESENT TIME.

I shall not attempt in this sketch to trace those methods which are not applicable to iron ores, among which may be mentioned the lead, (*b*) mercury, (*b*) uranium, (*c*) and tin (*d*) methods, and that based on the separation and weighing of ferric phosphate and the titration of the iron by solution of permanganate. (*e*)

The first step toward an accurate method for the estimation of phosphoric acid in presence of iron was taken when Otto, (*f*) in 1844, suggested its precipitation as $Mg_2(NH_4)_2P_2O_8$ by adding magnesic sulphate to an ammoniacal liquid in which the Fe_2O_3 was kept in solution by tartaric acid.

The separation of this acid from a large excess of ferric oxide was still very difficult, and the results obtained were very inaccurate.

In 1846 Svanberg & Struve (*g*) discovered the reaction of phosphoric acid with ammonic molybdate, and Rose (*h*) confirmed their statements. This, however, was only qualitative.

R. Weber, (*i*) in 1846, showed the necessity for converting any pyrophosphoric into orthophosphoric acid, and recommended heating with H_2SO_4 to accomplish this result.

About this time Fresenius (*j*) published the method which is largely the same as that which is now known as the acetate method. It is in substance as follows: Reduce the iron in the acid solution with Na_2SO_3 until Na_2CO_3 produces a white precipitate; boil off all SO_2, neutralize nearly with Na_2CO_3, add a few drops of chlorine water and excess of sodic acetate; add chlorine water until the liquid is red, boil until it clears, and filter hot. The precipitate contains all the P_2O_5. Dissolve this precipitate in HCl and precipitate the iron by NH_4HO and $(NH_4)_2S$, or precipitate, after reducing with Na_2SO_3, by NaHO, boiling hot, filter, and in the filtrate precipitate with magnesium mixture and ammonia.

He stated that neither citric acid nor sugar possessed any advantage over tartaric acid in preventing the precipitation of small amounts of iron with the $Mg_2(NH_4)_2P_2O_8$.

J. C. Nesbitt (*k*) claimed that the precipitate of $Mg_2(NH_4)_2P_2O_8$, from a solution containing $MgSO_4$, NH_4Cl, NH_4HO, Fe_2O_3, and Al_2O_3, contained varying amounts of Fe_2O_3 and Al_2O_3 unless the solution was very dilute and contained a great excess of tartaric acid and ammonia; and Fresenius (*l*) stated that at a certain degree of concentration a precipitate was thrown down from a solution containing only Mg_2SO_4, NH_4Cl, tartaric acid, and ammonia.

Rose, a little later, published an account of the various methods for the determination of P_2O_5, and said, among other things, in regard to the precipitate of $Mg_2(NH_4)_2P_2O_8$, that the solution, after the addition of $MgSO_4$, NH_4Cl, and NH_4HO, should stand for some hours, and should not be heated above 30°.

The precipitate should be washed (according to Fresenius) with ammonia water, and the presence of a great excess of ammoniacal and other salts, Rose stated, had no influence upon the precipitation. He added that $(NH_4)_2CO_3$ threw down an insoluble double salt of Mg and NH_4, and should not be used instead of NH_4HO, and also that P_2O_5 could not be perfectly separated from iron by $(NH_4)_2S$, for while the FeS contained no P_2O_5, the filtrate deposited iron with the $Mg_2(NH_4)_2P_2O_8$. He also suggested the precipitation of P_2O_5 by $BaCO_3$.

Sonnenschein (*m*) first used, about 1850, the molybdate method quantitatively. He used a solution containing 1 part ammonic molybdate and 20 parts HNO_3. Of this solution he used 30 times as much as was necessary to precipitate the P_2O_5, allowed it to stand several hours at a gentle heat, filtered, washed with the precipitant dissolved on the filter in NH_4HO, and then precipitated by Mg mixture.

Ullgren, (*n*) about the same time, proposed the following method: A solution of the iron ore in HCl, or of the

a This convenient little crucible is made and perforated in the best possible manner by J. Bishop, of Sugartown, Pa.
b Pogg. Ann., lxxvi, 218.
c Leconte, Compt. Rend., xxix, 55.
d Compt. Rend., xxxiii, 385.
e Raewsky, Compt. Rend., xxiv, 681.
f Ann. d. Pharm., viii, 142, 167.
g Jour. für Pr. Chem., xliv, 291.
h Pogg. Ann., lxxvi, 26.
i Pogg. Ann., lxxiii, 137.
j Jour. für Pr. Chem., xlv, 258.
k Jour. Chem. Soc., i, 44.
l Jour. Pr. Chem., xlv, 259.
m Jour. Pr. Chem., liii, 339.
n Jour. Pr. Chem., liii, 33.

iron in HNO_3, evaporated to a sirupy consistency with HCl and diluted, was poured into a solution of potassic sulphide and potassic silicate (1 gram of iron to 5 grams potassic sulphide and 1 gram potassic silicate). The precipitate contained MgO, CaO, Al_2O_3, and sulphides of positive metals; the filtrate, potassic phosphate, and sulphides of negative metals. The filtrate was mixed with freshly precipitated $PbCO_3$, filtered and washed with water containing one-tenth its volume of a concentrated solution of $(NH_4)_2CO_3$ and NH_4HO. The filtrate was evaporated to dryness, the mass moistened with HCl, diluted, and filtered from SiO_2. Filtrate contained P_2O_5 and traces of Fe_2O_3, etc. Tartaric acid was added, and P_2O_5 precipitated by Mg mixture as usual. He also suggested adding ferrocyanide of potassium and K_2S to the nitric-acid solution of the iron containing tartaric acid, ammonia, and magnesic sulphate, filtering off the precipitate of S and $Mg_2(NH_4)_2P_2O_8$, and fusing with Na_2CO_3, and determining P_2O_5 in the filtered solution, after acidulating with HCl, by Mg mixture.

Kremers (*a*) gave the proper strength of ammonia water for washing the precipitate of $Mg_2(NH_4)_2P_2O_8$ as 3 parts water to 1 part NH_4HO. He said that the precipitate dissolved in all other mixtures.

W. Wicke (*b*) recommended molybdate of lead instead of molybdate of ammonia as a precipitant of P_2O_5.

W. Knop (*c*) stated that pure silicate of potash treated with HNO_3 and ammonic molybdate gave a precipitate similar to that obtained from a small amount of P_2O_5.

Damour and H. Sainte-Claire Deville, (*d*) in 1858, showed that oxide of cerium added to an acid solution of P_2O_5 gave a pale yellow precipitate.

Staedeler (*e*) recommended Otto's method, but suggested redissolving and reprecipitating the first precipitate of $Mg_2(NH_4)_2P_2O_8$.

A. Lipowitz (*f*) suggested the use of a molybdate solution containing 2 MoO_3, 1 tartaric acid, 15 water, 10 NH_4HO, and 15 HNO_3. After adding the precipitant to the solution of iron containing P_2O_5, he heated it to boiling, and weighed the precipitated phospho-molybdate of ammonia on a counterpoised filter, dried at 20° or 30°, or better, over H_2SO_4. The precipitate contained 3.607 per cent. P_2O_5.

H. Struve (*g*) dissolved the iron in HNO_3 and HCl, evaporated to dryness, redissolved in HCl, and filtered from SiO_2, precipitated by NH_4HO, fused precipitate with Na_2CO_3, dissolved in hot water, filtered, and determined P_2O_5 in filtrate by Mg mixture.

V. Eggertz, (*h*) in 1860, recommended the molybdate method. He dissolved MoO_3 in 4 parts NH_4HO, and filtered into 15 parts HNO_3 (1.2 sp. gr.).; dissolved the iron or steel in HNO_3, evaporated to dryness, redissolved in HCl, added molybdate solution, and set it aside at a temperature of 40°, with occasional stirring for 2 or 3 hours. He filtered the dried precipitate at 95°, and weighed. The precipitate contained 3.74 per cent. P_2O_5.

C. Chancel (*i*) treated the iron ore with HNO_3, precipitated any H_2SO_4 with $BaCl_2$, and HCl with $AgNO_3$; precipitated the Ag and reduced the iron with H_2S, boiled off in current of CO_2, and precipitated P_2O_5 with nitrate of bismuth. The precipitate contained 31.28 per cent. P_2O_5.

R. Warrington, jr., (*j*) recommended the use of citric acid instead of tartaric acid, to avoid precipitation of Mg salts with the $Mg_2(NH_4)_2P_2O_8$.

Fr. Mohr (*k*) showed that the precipitate in a solution of iron by sodic phosphate had the formula $Fe_2O_3P_2O_5$. On long washing the precipitate was decomposed P_2O_5 and Fe_2O_3, dissolving with an acid reactive.

Schloessing (*l*) ignited the phosphate in a mixture of SiO_2, then transferred to a carbon boat, and heated in a porcelain tube in a current of CO. The loss of weight was P_2O_5. If the porcelain tube is connected with a silver tube heated to redness and containing Cu, the Cu takes up all the P from its volatile compound; or if the gas from the porcelain tube is led into a bulb apparatus containing $AgNO_3$ and warmed in a water-bath to 80° or 90° C., the silver phosphide collected here and the red phosphorus remaining in the tube may be oxidized with HNO_3, evaporated to dryness, heated to incipient fusion, extracted with water, and the residue weighed as 3 $Ag_2OP_2O_5$.

R. Warrington, jr., (*m*) recommended neutralizing the nitric-acid solution after separation of SiO_2 with NH_4HO, and precipitating with acetate of lead (or with $Pb(NO_3)_2$ and PbO). The lead phosphate, after washing with warm water containing some ammonic acetate, was dissolved in dilute HNO_3 and decomposed with H_2S. From the filtrate, which contained all the P_2O_5 with very little iron, the P_2O_5 was precipitated after the addition of a little citric acid by Mg mixture.

R. Fresenius (*n*) remarked, in regard to the molybdate method: 1. HNO_3, even in large excess, did not influence the exactness of the method. 2. HCl in large amount prevented, partially or entirely, the precipitation of the phospho-molybdate; 3.3 per cent. of HCl gave results that were approximate, but still too low. 3. In the presence of much HNO_3, HCl was still more disadvantageous. 4. H_2SO_4, Fe_2Cl_6, Al_2Cl_6, even in large amount, did not influence the result. 5. With much NH_4Cl the results were too low, as they were also when the solution was very dilute.

F. Knapp (*o*) and R. Pribram (*p*) claimed that in a solution containing much Al_2O_3 the precipitation of the $Mg_2(NH_4)_2P_2O_8$ in the presence of tartaric acid and ammonia was entirely prevented.

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a Pogg. Ann., lxxxiv, 77.
b Ann. Ch. Phar., xcv, 373.
c Chem. Centr., 1857, 691 and 861.
d Inst., 1858, 69.
e Ann. Ch. Pharm., cix, 306.
f Pogg. Ann., cix, 135.
g Jour. Pr. Chem., lxxix, 321.
h Jour. Pr. Chem., lxxix, 496.
i Compt. Rend., li, 882.
j Jour. Chem. Soc., xvi, 304.
k Zeit. Anal. Chem., ii, 230.
l Compt. Rend., lix, 384.
m Chem. News, xi.
n Zeit. Anal. Chem., iii, 446.
o Zeit. Anal. Chem., 1865, 473.
p Vierteljahrschr. Pr. Pharm., xv, 184.

J. Spiller (*a*) treated the HCl solution with ammonic bisulphite, drove off the excess of SO_2 by heating, cooled the solution to 20° C., and added a solution of ammonic carbonate until the precipitate, at first red, became greenish in color. This precipitate, which contained all the P_2O_5, was filtered off and dissolved in HCl, the iron separated according to Fresenius' method by $(NH_4)_2S$ and NH_4HO, and the P_2O_5 precipitated in the filtrate by Mg mixture.

Brassier (*b*) suggested the use of $MgCl_2$ instead of $MgSO_4$.

E. G. Tosh (*c*) recommended Spiller's method, but instead of separating the Fe_2O_3 and P_2O_5 by $(NH_4)_2S$ and NH_4HO, added citric acid to the HCl acid solution of the precipitate by ammonic carbonate, and precipitated the P_2O_5 by Mg mixture and ammonia, as $Mg_2(NH_4)_2P_2O_8$.

Tautin (*d*) proposed treating iron or steel with HCl in a flask, and passing the gases evolved through a solution of KHO to separate S, and then through a solution of nitrate of silver in which the phosphuretted hydrogen precipitates silver as phosphide. This phosphide of silver he filtered off and treated with aqua regia, which oxidized the P to P_2O_5 and rendered the Ag insoluble as chloride. The AgCl he filtered off, and determined the P_2O_5 in the filtrate.

W. Kübel (*e*) showed that $Mg_2(NH_4)_2P_2O_8$ was much less soluble in ammonia water than Fresenius supposed. As he found basic magnesic sulphate in this precipitate, he recommended re-solution and reprecipitation.

E. Kessel (*f*) stated that the amount of basic magnesic sulphate precipitated with the $Mg_2(NH_4)_2P_2O_8$ was very small if no great excess of $MgSO_4$ was used and sufficient NH_4Cl. He also claimed that the presence of soluble Mg salts decreased the solubility of the $Mg_2(NH_4)_2P_2O_8$, and that dilute ammonia dissolved it, the solvent action of this latter being increased by the presence of NH_4Cl.

Th. Petersen (*g*) restated the necessity for completely removing SiO_2 before precipitating P_2O_5 by molybdate solution.

F. Kessler (*h*) proposed to determine P in iron and steel by precipitating the Fe from solution by K_4FeCy_6, and in the filtrate determining P_2O_5 as $Mg(NH_4)_2P_2O_8$.

Meinicker (*i*) suggested dissolving iron or steel in double chloride of copper and ammonium, filtering, and treating the residue with HNO_3, and precipitating P_2O_5 in this solution with molybdate solution.

E. Richters (*j*) recommended washing the precipitate of ammonic phospho-molybdate with solution of ammonic nitrate.

E. W. Parnell (*k*) showed the insolubility of $Mg_2(NH_4)_2P_2O_8$ in ammoniacal liquids containing excess of Mg salt or sodic phosphate.

J. Parry (*l*) dissolved iron or steel in aqua regia, and after separating SiO_2 transferred the HCl solution to a flask and added sufficient ammonia to precipitate all the Fe_2O_3, then just enough HNO_3 to dissolve the precipitate. He heated the solution nearly to boiling, and added an excess of an aqueous solution of ammonic molybdate. If there was no precipitate he added HNO_3, drop by drop, shaking the flask constantly until a distinct precipitate appeared, after which he added a small additional amount of HNO_3, shook the flask well, and allowed the precipitate to settle for a few minutes. He filtered, washed with water containing a little HNO_3, and weighed the precipitate of phospho-molybdate of ammonia, which contained 1.63 per cent. of P.

T. R. Ogilvie (*m*) made a number of experiments to show the effect of varying amounts of Mg salts, citric acid, Al_2O_3, Fe_2O_3, and ammonic oxalate on the precipitation of P_2O_5 as $Mg_2(NH_4)_2P_2O_8$.

E. W. Parnell (*n*) said, in answer to Ogilvie, that the purity of the precipitate of $Mg_2(NH_4)_2P_2O_8$ was not affected by the quantity of the Mg salts, but by the manner of precipitation. He recommended the use of dilute solutions, and said they should stand quiet for a long time.

W. Flight (*o*) discussed various methods and recommended—

1. To separate P_2O_5 from Fe_2O_3, he passed H_2S through the weak acid solution, then added $(NH_4)_2S$ in excess, boiled, filtered, washed with H_2S water, and determined P_2O_5 in filtrate.

2. From Al_2O_3 he added excess of NaHO to solution, then $BaCl_2$ to precipitate all the P_2O_5, allowed to stand several hours protected from CO_2, filtered and washed with NaHO water, decomposed precipitate and determined P_2O_5.

3. From Fe_2O_3 and Al_2O_3 he treated the not too acid solution with excess of $Na_2S_2O_3$, boiled, filtered P_2O_5 partly with Al_2O_3 in precipitate and partly wtih FeO in filtrate. He then separated P_2O_5 by methods I and II. and II.

T. E. Cairns (*p*) showed the inaccuracy of Sonnenschein's molybdate method when the solution was not heated above 40° C., unless it was allowed to stand several days. He recommended dissolving the iron or steel in HCl and $KClO_3$, evaporating to dryness to get rid of SiO_2, precipitating the Fe_2O_3 and P_2O_5 by NH_4HO, filtering, dissolving this precipitate in HNO_3, and evaporating down, diluting to 250 c.c., neutralizing by NH_4HO, adding

a Jour. Chem. Soc. (2), iv, 148.
b Ann. Chem. Phys. [4], vii, 355.
c Chem. News, xvi, 168.
d Chem. News, xviii, 252.
e Zeit. Anal. Chem., viii, 125.
f Zeit. Anal. Chem., viii, 164.
g Verhandl. Geolog. Reichsanst., 1869, 80.
h Jour. Pr. Chem. [2], 2, 364.
i Zeit. Anal. Chem., 1871, p. 280.
j Zeit. Anal. Chem., 1871, 305.
k Chem. News, xxiii, 145.
l Chem. News, xxv, 229.
m Chem. News, xxxi, 274; xxxii, 5, 12, 70.
n Chem. News, xxxii, 222.
o Jour. Chem. Soc., xxviii, 592.
p Am. Chemist., vii, 215.

"molybdate solution," heating nearly to boiling and allowing the phospho-molybdate to settle. He recommended washing this precipitate with "molybdic acid solution", dissolving in NH_4HO, neutralizing by HCl, and precipitating the P_2O_5 by Mg mixture.

O. Korschelt (*a*) suggested the use of potassic molybdate instead of ammonic molybdate. He prepared the solution by dissolving 1 part MoO_3 in 1 part KHO and 6 parts water, after cooling adding a solution of ½ part tartaric acid in 2 parts water, and finally 7½ parts nitric acid, boiling and filtering while hot. He dissolved the iron or steel in the smallest possible amount of boiling nitric acid, filtered, and added the heated solution to an excess of the molybdate solution in a capsule, also heated on the water-bath. He filtered on a balanced filter, washed with dilute HNO_3 and then with alcohol, dried at 120° to 130° C., and weighed. The precipitate contained 1 73 per cent. P.

Boussingault (*b*) used the fact of the insolubility of phosphate of cerium (pointed out by Damour and Deville) in HNO_3 in the determination of P_2O_5 in iron and steel.

Finkmer (*c*) approved of Sonnenschein's method, and suggested the addition of an increased amount of NH_4NO_3 and the washing of the precipitate with a solution of ammonic nitrate and nitric acid. He washed the precipitate into a weighed crucible, evaporated off the water, heated it over wire-gauze to expel the NH_4NO_3, and weighed the ammonic phospho-molybdate. It contained 3.794 per cent. P_2O_5.

E. Riley (*d*) recommended most strongly the acetate method, using $MgCl_2$ instead of $MgSO_4$ in his magnesia mixture, and citric acid to keep the Fe_2O_3 in solution. He considered a large amount of citric acid necessary. He allowed the solution to stand over night before stirring, then stirred vigorously, and allowed to stand for 24 hours before filtering off the precipitate of $Mg_2(NH_4)_2P_2O_8$. He suggested, also, a combination of the acetate and molybdate methods by dissolving the acetate precipitate in HCl, adding excess of NH_4HO, acidulating by HNO_3, and precipitating by ammonic molybdate, filtering and weighing the phospho-molybdate of ammonia.

For the determination of P_2O_5 in iron ores, iron, and steel there are practically but two methods in general use at the present day—the molybdate and the acetate—unless we consider a combination of the two as a separate method. Each has its ardent admirers, but the general opinion among chemists of experience is, that either method will give accurate results if proper care and skill are used in carrying out the details of the work. I propose to point out those details which require special care in each method, and want of attention to which may cause serious errors in the results. The presence of titanic acid, unless the precautions mentioned in the method given in my report for the determination of P_2O_5 are observed, will be a fruitful source of error in either, and arsenic acid, unless carefully separated, will cause too high results, whichever method be used.

1. In the molybdate method the first point to be observed is the destruction of the carbonaceous matter, especially in the case of irons and steel. I first observed this in 1877 in an investigation of Korschelt's method, which is mentioned in a paper by Hunt and Peters (*e*) to whom I communicated the fact in 1878. Finkmer (*f*) mentioned the same thing in the same year, and says, very truly, "0.10 per cent. of P in a steel may easily be entirely overlooked by inattention to this fact."

2. If the solution of the steel or iron in HNO_3 is evaporated to dryness, and the residue is ignited to destroy carbonaceous matter, it must be redissolved in HCl, for very often the ignited ferric phosphate is quite insoluble in HNO_3. This requires repeated evaporations with HNO_3 to get rid of HCl, which is considered deleterious by such analysts as Fresenius and Finkmer.

3. Silica must be removed from the solution before adding the molybdate solution, unless the P_2O_5 be finally precipitated as $Mg_2(NH_4)_2P_2O_8$.

4. After adding the molybdate solution, great care must be exercised on two points—the degree of acidity and the temperature of the solution. The phospho-molybdate of ammonia will not precipitate readily if the solution is too acid or the temperature too low, and a continued high temperature or boiling of the solution tends to the precipitation of an excess of molybdic acid with the ammonic phospho-molybdate. The most careful analysts direct that the solution should stand from 6 to 24 hours before filtering, and that the filtrate should always be tested by a fresh addition of molybdate solution.

5. If the P_2O_5 is finally weighed as $Mg_2P_2O_7$ it is very difficult to get rid of the last traces of molybdic acid. After two precipitations as $Mg_2(NH_4)_2P_2O_8$, I have found appreciable amounts of MoO_3 in the HCl solution of the ignited $Mg_2P_2O_7$.

In the acetate method the first point which requires special attention is: 1. Driving off the excess of SO_2. It is very necessary to do this, as ferric phosphate is soluble in SO_2 and in ammonic sulphite.

2. Both care and experience are necessary in neutralizing the deoxidized solution, for all the free HCl must be neutralized, and enough NH_4HO added to precipitate all the ferric phosphate and ferric oxide, and an excess over this should be avoided as tending to obscure the reaction and causing an excess of ammonic acetate, which is deleterious. On the other hand, if all the Fe_2O_3 is not precipitated, there will be loss, for ferric phosphate is soluble in ferric chloride.

3. The precipitate of ferric phosphate and oxide should not be washed much (one washing is ample), as ferric phosphate is decomposed by pure water. My own personal preference is for the acetate method, and for the

a Dingler's Pol. Jour., ccxxv, 158.
b Dingler's Pol. Jour., 1872, p. 223.
c Deut. Chem. Ges. Bu., 10, pp. 1638–1641.
d Chem. Soc. Jour., 1878, i, 104.
e Metallurgical Review, vol. ii, p. 365.
f Deut. Chem. Ges. Bu., 10, pp. 1638–1641.

following reasons: 1. The sources of error are fewer and are more easily guarded against. 2. If the proper precautions are taken in each method, the acetate is the quicker. I have made many determinations (the accuracy of which was afterward proven by other results) in iron ores in 24 hours and in steels in 48. 3. There is not the same temptation in the acetate method that there is in the molybdate to take short cuts, which has brought many a young chemist to grief. 4. Experience has shown (*a*) that the molybdate method, as practiced by many chemists, is not as accurate although it may be shorter than the acetate.

An accurate determination of P_2O_5, by whatever method it is made, requires much skill and not a little practice, and the advocate of one method often makes the other suffer in comparison, more by reason of his own want of skill in the manipulation of the other method than by reason of any great advantage inherent in his own.

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a E. Riley, Jour. Chem. Soc., 1878, i, 104, besides numerous cases which have come under my own observation.

TABLE 25.—PARTIAL ANALYSES OF IRON ORES.

TABLE 25.—*Partial analyses of iron ores.*

LAKE SUPERIOR REGION.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	Blair	Willis	From 20,000 tons at Cleveland	Specular No. 1	140	Jackson, Marquette county, Michigan
2	do	do	Fine ore, from same pile as No. 140	Specular	150	do
3	Pitman	do	From 15,000 tons at Cleveland	Specular No. 1	113	Cleveland, Marquette county, Michigan.
4	Gooch	do	From 1,000 tons, selected ore, at Cleveland	Specular No. 2; green.	131	do
5	Blair	Putnam	From southeastern part of pit No. 1	Specular	88	New York, Marquette county, Michigan.
6	do	do	From 200 tons of ore from shaft near the Beardsley pit.	Specular with martite.	89	do
7	Pitman	Willis	From 9,000 tons at Cleveland	Specular No. 1	114	do
8	Gooch	do	From 1,000 tons at Cleveland	Specular No. 2	115	do
9	Pitman	do	From 1,500 tons at Cleveland	Specular No. 2 "Essex"	142	Lake Superior, Marquette county, Michigan.
10	do	do	Fine ore, from 20.000 tons, at Cleveland	Specular	149	do
11	do	do	From 20,000 tons at Cleveland	Specular No. 1	141	do
12	Blair	do	From 4,000 tons at Cleveland	Specular	139	do
13	Gooch	do	From 2,000 tons at Cleveland	Specular	129	Barnum, Marquette county, Michigan.
14	Pitman	Putnam	Across west side of pump-shaft pillar	Specular	11	Lake Angeline, Marquette county, Michigan.
15	do	do	From west side of west pit, 135 feet from pump-shaft.	Hematite	12	do
16	do	do	From northeast side of west pit, near pump-shaft pillar.	Limonite	13	do
17	do	Willis	From 4,000 tons at North Chicago Rolling Mill	Specular	108	do
18	Blair	do	From 3,000 tons at "River Furnaces" of Cleveland Rolling Mill Company, Cleveland.	Specular	144	Saginaw, Marquette county, Michigan.
19	Gooch	Fay	Average of output	Specular	10	Boston, Marquette county, Michigan
20	Blair	Pumpelly	Average of output	Specular	A	Sterling, Marquette county, Michigan
21	do	do	Granular ore	do	B	do
22	do	do	Slaty ore	do	C	do
23	Pitman	Willis	From 4,000 tons at Cleveland	Magnetite	120	Humboldt, Marquette county, Michigan.
24	Blair	do	From 1,000 tons at Cleveland	Magnetite	132	Edwards, Marquette county, Michigan.
25	do	do	From 1,000 tons at Cleveland; "slate ore"	Specular	133	do
26	Gooch	do	From 7,000 tons at Cleveland	Magnetite No. 1	103	Champion, Marquette county, Michigan.
27	Pitman	do	From 4,000 tons at Cleveland	Magnetite and specular.	104	do
28	Gooch	do	From 1,500 tons at Cleveland	Specular and magnetite No. 2.	130	do
29	do	do	Fine ore from same pile as No. 103	Magnetite	147	do
[illegible]	Pitman	do	From 1,000 tons at Cleveland	Magnetite	127	Keystone, Marquette county, Michigan.
31	Blair	do	From 2,000 tons at "River Furnaces" of Cleveland Rolling Mill Company.	do	143	do
32	do	Putnam	From stope, pit No. 4, fourth level, 130 feet east of shaft.	Magnetite	1	Michigamme, Marquette county, Michigan.
33	do	do	From stope, pit No. 4, first level, 375 feet east of shaft.	do	2	do
34	do	do	From stope, pit No. 1, second level, 140 feet west of shaft.	do	3	do
35	do	do	From winze, 100 feet west of shaft No. 1, 35 feet below surface.	do	4	do
36	do	Willis	From 4,000 tons at Cleveland	do	110	do
37	do	do	Fine ore from same pile as No. 110	do	148	do
38	Pitman	do	From 800 tons at Cleveland	Magnetite	121	Spurr Mountain, Baraga county, Michigan.
39	Gooch	Putnam	From pillar in pit No. 5, fourth level, 70 feet south from shaft; from foot-wall to schist "horse".	Specular	5	Republic, Marquette county, Michigan.
40	do	do	From same pillar, from schist "horse" to hanging-wall.	Magnetite	7	do
41	do	do	From stope in Morgan shaft, 135-foot level	Specular	8	do
42	do	do	From stope in Ely pit, 200-foot level	do	9	do

TABLE 25.—*Partial analyses of iron ores.*

LAKE SUPERIOR REGION.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.044	64.84	S 0.027 p. ct.; SiO_2 4.02 p. ct.; Al_2O_3 1.76 p.ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.00 p. ct.; specific gravity, 5.029.	0.044	65.00	S 0.027 p. ct.; SiO_2 4.03 p. ct.; Al_2O_3 1.76 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.00 p. ct.	0.068	1
0.064	62.09	S 0.027 p. ct.; SiO_2 5.69 p. ct.; Al_2O_3 2.78 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 8.46 p. ct.	0.064	62.09	S 0.027 p. ct.; SiO_2 5.69 p. ct.; Al_2O_3 2.78 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 8.46 p. ct.	0.103	2
0.109	64.47	S 0.049 p. ct.; SiO_2 3.76 p. ct.; Al_2O_3 2.90 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 5.03 p. ct.; specific gravity, 4.965.	0.109	64.47	S 0.049 p. ct.; SiO_2 3.76 p. ct.; Al_2O_3 2.90; Mn. trace; TiO_2 0.00; insoluble, 5.03 p. ct.	0.169	3
0.170	56.80	S 0.00; SiO_2 10.93 p. ct.; Al_2O_3 4.03 p. ct.; Mn. present; TiO_2 0.00; insoluble, 14.51 p. ct; specific gravity, 4.795.	0.170	56.86	S 0.00; SiO_2 10.94 p. ct; Al_2O_3 4.03 p. ct.; Mn. present; TiO_2 0.00; insoluble 14.51 p. ct.	0.299	4
0.062	67.34	S. 0.060 p. ct.; specific gravity, 4.949. Complete analysis.	0.062	67.41	S 0.060 p. ct	0.092	5
0.195	63.81	S. 0.030 p. ct.; specific gravity, 5.033. Complete analysis.	0.195	63.81	S 0.030 p. ct	0.306	6
0.110	64.40	S 0.026 p. ct.; SiO_2 5.10 p. ct.; Al_2O_3 2.20 p. ct.; Mn. 0.00; insoluble, 5.93 p. ct.; specific gravity, 4.292.	0.110	64.40	S 0.026 p. ct.; SiO_2 5.10 p. ct; Al_2O_3 2.20 p. ct.; Mn. 0.00; insoluble, 5.93 p. ct.	0.171	7
0.164	61.34	S 0.086 p. ct.; SiO_2 5.82 p. ct.; Al_2O_3 2.98 p. ct.; Mn. present; insoluble, 7.07 p. ct.; specific gravity, 4.906.	0.164	61.34	S 0.086 p. ct.; SiO_2 5.82 p. ct.; Al_2O_3 2.98 p. ct.; Mn. present; insoluble, 7.07 p. ct.	0.267	8
0.057	55.92	S 0.074 p. ct.; SiO_2 14.51 p. ct.; Al_2O_3 4.02 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 17.65 p. ct.; specific gravity, 4.318.	0.057	55.95	S 0.074 p. ct.; SiO_2 14.52 p. ct.; Al_2O_3 4.02 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 17.66 p. ct.	0.102	9
0.057	63.38	S 0.057 p. ct.; SiO_2 4.66 p. ct.; Al_2O_3 3.13 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 7.58 p. ct.	0.057	63.42	S 0.057 p. ct.; SiO_2 4.66 p. ct.; Al_2O_3 3.13 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 7.59 p. ct.	0.090	10
0.057	64.38	S 0.074 p. ct.; SiO_2 4.27 p. ct.; Al_2O_3 0.91 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.43 p. ct.; specific gravity, 4.962.	0.057	64.38	S 0.074 p. ct.; SiO_2 4.27 p. ct.; Al_2O_3 0.91 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.43 p. ct.	0.089	11
0.016	64.77	S 0.055 p. ct.; SiO_2 3.65 p. ct.; Al_2O_3 2.28 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.35 p. ct.; specific gravity, 4.990.	0.016	64.83	S 0.055 p. ct.; SiO_2 3.65 p. ct.; Al_2O_3 2.28 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.36 p. ct.	0.025	12
0.096	63.45	S 0.011 p. ct.; SiO_2 5.47 p. ct.; Al_2O_3 2.41 p. ct.; Mn. 0.00; TiO_2 absent; insoluble, 7.12; specific gravity, 4.946.	0.096	63.50	S 0.011 p. ct.; SiO_2 5.47 p. ct.; Al_2O_3 2.41 p. ct; Mn. 0.00; TiO_2 0.00; insoluble, 7.12 p. ct.	0.151	13
0.007	55.11	Specific gravity, 4.814	0.007	55.11		0.013	14
0.061	53.85	Specific gravity, 3.829	0.061	53.96		0.113	15
0.051	42.27	Specific gravity, 2.774	0.051	42.33		0.121	16
0.031	46.91	S 0.039 p. ct.; SiO_2 27.72 p. ct.; Al_2O_3 4.15 p. ct.; Mn. 0.00; insoluble, 30.59 p. ct.; specific gravity, 4.077.	0.031	46.93	S 0.039 p. ct.; SiO_2 27.72 p. ct.; Al_2O_3 4.15 p. ct.; Mn. 0.00; insoluble, 30.59 p. ct.	0.066	17
0.106	62.53	S 0.057 p. ct.; SiO_2 5.47 p. ct.; Al_2O_3 2.53 p. ct.; Mn. 0.00; TiO_2 trace; insoluble, 8.68 p. ct.; specific gravity, 4.963	0.106	59.44	S 0.057 p. ct.; SiO_2 5.47 p. ct.; Al_2O_3 2.53 p. ct.; Mn. 0.00; TiO_2 trace; insoluble, 8.68 p. ct.	0.170	18
0.009	66.36	S 0.007 p. ct. Complete analysis	0.009	66.37	S 0.007 p. ct.	0.014	19
0.053	64.76		0.053	64.76		0.082	20
0.039	64.49		0.039	64.50		0.060	21
0.025	64.98		0.025	64.99		0.039	22
0.154	63.79	S 0.005 p. ct.; SiO_2 7.61 p. ct.; Al_2O_3 2.34 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 8.12 p. ct.; specific gravity, 4.851.	0.154	63.85	S 0.005 p. ct.; SiO_2 7.62 p. ct.; Al_2O_3 2.34 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 8.13 p. ct.	0.241	23
0.072	59.89	S 0.096 p. ct.; SiO_2 7.98 p. ct.; Al_2O_3 5.06 p. ct.; Mn. present; TiO_2 present; insoluble, 11.52 p. ct.; specific gravity, 4.726.	0.072	59.91	S 0.096 p. ct.; SiO_2 7.98 p. ct.; Al_2O_3 5.06 p. ct.; Mn. present; TiO_2 present; insoluble, 11.52 p. ct.	0.120	24
0.107	60.02	S 0.199 p. ct.; SiO_2 6.30 p. ct.; Al_2O_3 4.08 p. ct.; Mn. 0.00; TiO_2 present; insoluble, 11.10 p. ct.; specific gravity, 4.739.	0.107	60.05	S 0.199 p. ct.; SiO_2 6.30 p. ct.; Al_2O_3 4.08 p. ct.; Mn. 0.00; TiO_2 present; insoluble, 11.10 p. ct.	0.178	25
0.039	64.01	S 0.099 p. ct.; SiO_2 4.92 p. ct.; Al_2O_3 3.15 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 7.36 p. ct.; specific gravity, 4.668.	0.039	64.06	S 0.099 p. ct.; SiO_2 4.92 p. ct.; Al_2O_3 3.15 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 7.37 p. ct.	0.060	26
0.044	60.70	S 0.064 p. ct.; SiO_2 6.29 p. ct.; Al_2O_3 6.08 p. ct.; Mn. present; TiO_2 0.70 p. ct.; insoluble, 9.84 p. ct.; specific gravity, 4.523.	0.044	60.72	S 0.064 p. ct.; SiO_2 6.29 p. ct.; Al_2O_3 6.08 p. ct.; Mn. present; TiO_2 0.70 p. ct.; insoluble, 9.84 p. ct.	0.073	27
0.035	59.17	S 0.00; SiO_2 8.03 p. ct.; Al_2O_3 5.35 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 12.29 p. ct.; specific gravity, 4.635 p. ct.	0.035	59.20	S 0.00; SiO_2 8.03 p. ct.; Al_2O_3 5.35 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 12.30 p. ct.	0.059	28
0.038	66.75	S 0.085 p. ct.; SiO_2 2.60 p. ct.; Al_2O_3 1.90 p. ct.; Mn. present; TiO_2 0.00; insoluble, 3.94 p. ct.	0.038	66.84	S 0.085 p. ct.; SiO_2 2.60 p. ct.; Al_2O_3 1.90 p. ct; Mn. present; TiO_2 0.00; insoluble, 3.94 p. ct.	0.057	29
0.548	60.05	S 0.102 p. ct.; SiO_2 6.69 p. ct.; Al_2O_3 3.59 p. ct.; Mn. 0.00; TiO_2 0.012 p. ct.; insoluble, 9.91 p. ct.; specific gravity, 4.567.	0.548	60.05	S 0.102 p. ct.; SiO_2 6.69 p. ct.; Al_2O_3 3.59 p. ct.; Mn. 0.00; TiO_2 0.012 p. ct.; insoluble, 9.91 p. ct.	0.913	30
0.314	59.17	S 0.055 p. ct.; specific gravity, 4.597. Complete analysis.	0.315	59.34	S 0.055 p. ct	0.531	31
0.095	63.55	S 0.103 p. ct. Complete analysis	0.095	63.58	S 0.103 p. ct	0.149	32
0.092	56.35	S 0.237 p. ct.; SiO_2 15.14 p. ct.; Mn. present; TiO_2 0.00	0.092	56.36	S 0.237 p. ct.; SiO_2 15.14 p. ct.; Mn. present; TiO_2 0.00	0.163	33
0.042	59.95	S 0.068 p. ct.; SiO_2 13.75 p. ct.; Mn. present; TiO_2 0.00; specific gravity, 4.659.	0.042	59.96	S 0.068 p. ct.; SiO_2 13.75 p. ct.; Mn. present; TiO_2 0.00	0.070	34
0.053	65.24	S 0.027 p. ct.; specific gravity, 4.865. Complete analysis.	0.053	65.25	S 0.027 p. ct	0.081	35
0.118	61.95	S 0.109 p. ct.; SiO_2 7.09 p. ct.; Al_2O_3 1.98 p. ct.; Mn. present; TiO_2, 0.00; insoluble, 8.28 p. ct.; specific gravity, 4.568.	0.118	61.96	S 0.109 p. ct.; SiO_2 7.09 p. ct.; Al_2O_3 1.98 p. ct.; Mn. present; TiO_2 0.00; insoluble, 8.28 p. ct.	0.190	36
0.101	60.98	S 0.261 p. ct.; SiO_2 7.60 p. ct.; Al_2O_3 2.96 p. ct.; Mn. present; TiO_2 0.00; insoluble, 8.25 p. ct.	0.101	61.02	S 0.261 p. ct.; SiO_2 7.61 p. ct.; Al_2O_3 2.96 p. ct.; Mn. present; TiO_2 0.00; insoluble, 8.26 p. ct.	0.166	37
0.114	62.21	S 0.016 p. ct.; SiO_2 6.91 p. ct.; Al_2O_3 2.88 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 7.39 p. ct.; specific gravity, 4.564.	0.014	62.27	S 0.016 p. ct.; SiO_2 6.92 p. ct.; Al_2O_3 2.88 p. ct.; Mn. trace; TiO_2 0.00; insoluble, 7.40 p. ct.	0.183	38
0.024	67.02	S 0.037 p. ct.; specific gravity, 5.113. Complete analysis.	0.024	67.02	S 0.037 p. ct	0.036	39
0.051	69.62	S 0.050 p. ct.; specific gravity, 5.071. Complete analysis.	0.051	69.69	S 0.050 p. ct	0.073	40
0.061	64.01	Specific gravity, 4.136	0.061	64.03		0.095	41
0.033	68.17	Specific gravity, 4.639	0.033	68.19		0.048	42

TABLE 25.—*Partial analyses of iron ores*—Continued.

LAKE SUPERIOR REGION—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
43	Pitman	Willis	From 25,000 tons at Cleveland	Specular	101	Republic, Marquette county, Michigan.
44	Gooch	do	From 600 tons at Cleveland	Magnetite	102	do
45	Pitman	do	Fine ore from same pile as No. 101	Specular	145	do
46	Gooch	do	Fine ore from same pile as No. 102	Magnetite	146	do
47	Pitman	do	From 4,000 tons at Cleveland	Hematite	136	Rolling Mill, Marquette county, Michigan.
48	do	do	From 1,200 tons at Cleveland	Hematite	112	Manganese, Marquette county, Michigan.
49	Blair	Putnam	From stope at west end of main pit near south wall.	do	85	McComber, Marquette county, Michigan
50	do	do	Same stope near north wall	do	86	do
51	do	do	From bottom of shaft about 130 feet west of engine-house, west of side of shaft.	do	87	do
52	Gooch	Willis	From 1,500 tons at Cleveland	do	111	do
53	Pitman	do	From 2,000 tons at Cleveland	Hematite	137	Jackson Hematite, Marquette county, Michigan.
54	do	do	From 6,000 tons at Cleveland	do	138	do
55	do	do	From 3,000 tons at Cleveland	Hematite	124	Cambria, Marquette county, Michigan.
56	Gooch	do	From 1,000 tons at Cleveland	Hematite	116	Bessemer, Marquette county, Michigan.
57	Pitman	do	From 5,000 tons at Cleveland	Hematite	122	Cleveland Hematite (Nelson), Marquette county, Michigan.
58	do	Putnam	From stope in pit No. 2, 90-foot level	Hematite	14	Salisbury, Marquette county, Michigan.
59	do	do	From drifts, 130-foot level	do	15	do
60	Blair	Willis	From 4,000 tons at North Chicago rolling-mill	do	109	do
61	Gooch	do	From 3,000 tons at Cleveland	do	126	Lake Superior Hematite, Marquette county, Michigan.
62	Blair	do	From 1,000 tons at Cleveland	do	105	Winthrop, Marquette county, Michigan.
63	do	do	From 2,000 tons at Cleveland	do	106	do
64	Pitman	do	From 3,000 tons at Cleveland	do	128	Lowthian, Marquette county, Michigan.
65	Gooch	do	From 8,000 tons at Cleveland	Specular	118	Palmer, Marquette county, Michigan
66	Pitman	do	From 2,000 tons at Cleveland	Hematite	123	Cheshire, Marquette county, Michigan.
67	do	Putnam	From breast of ore on south side of pit No. 1	Soft specular	77	Emmet, Menominee County, Michigan.
68	do	do	From exposure of ore near northwest side of pit No. 1.	Hematite	78	do
69	do	do	From 100 tons of ore at mine	Soft specular No. 2	79	do
70	do	do	From 1,700 tons of ore at mine	Hematite	80	do
71	do	do	From 600 tons of ore at mine	Soft specular	81	do
72	do	do	From west side of pit No. 1	Yellow ocher	84	do
73	Gooch	Willis	From 1,000 tons at Cleveland	Hematite	125	do
74	do	do	From 600 tons at Cleveland	Soft specular	107	do
75	Pitman	Putnam	From 125 tons of ore from drift in east pit	do	76	Breen, Menominee county, Michigan
76	do	do	From breast of ore on west side of west pit; "soft ore."	do	82	do
77	do	do	From breast of ore on west side of west pit; "hard ore."	do	83	do
78	Blair	do	From small piles of ore near exploration shafts and trench.	Hematite	67	Vulcan, section 11 (Lowell), Menominee county, Michigan.
79	do	do	From stope in east shaft, pit No. 3, 59 feet below surface.	Soft specular	60	Vulcan, Menominee county, Michigan.
80	do	do	In open part of pit No. 3, near foot-wall	do	61	do
81	do	do	From breast of ore on west side, pit No. 3	do	62	do
82	do	do	From side of drift 100 feet west from west shaft, 57 feet below surface.	do	63	do
83	do	do	From 3,000 tons at mine	Hematitic schist	64	do
84	do	do	From old stope in pit No. 1	Soft specular	65	do
85	do	do	From main stope in pit No. 1	do	66	do
86	Pitman	Willis	From 1,000 tons at Cleveland	do	134	do
87	Gooch	Putnam	Specimens from bottom of west pit	do	56	Curry, Menominee county, Michigan
88	do	do	Specimens of soft powder from near bend in vein.	do	57	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

LAKE SUPERIOR REGION—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.050	64.81	S 0.053 p. ct.; SiO_2 4.62 p. ct.; Al_2O_3 1.92 p. ct.; Mn. trace; insoluble, 5.86 p. ct. specific gravity, 4.872.	0.050	64.81	S 0.053 p. ct.; SiO_2 4.62 p. ct.; Al_2O_3 1.92 p. ct.; Mn. trace; insoluble, 5.86 p. ct.	0.077	43
0.081	67.52	S 0.008 p. ct.; SiO_2 2.78 p. ct.; Al_2O_3 2.03 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 4.61 p. ct.; specific gravity, 4.917.	0.081	67.56	S 0.008 p. ct.; SiO_2 2.78 p. ct.; Al_2O_3 2.03 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 4.61 p. ct.	0.120	44
0.042	67.03	S 0.054 p. ct.; SiO_2 2.33 p. ct.; Al_2O_3 1.30 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 3.05 p. ct.	0.042	67.07	S 0.054 p. ct.; SiO_2 2.33 p. ct.; Al_2O_3 1.30 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 3.05 p. ct.	0.062	45
0.062	69.13	S 0.022 p. ct.; SiO_2 1.60 p. ct.; Al_2O_3 1.09 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble 2.69 p. ct.	0.062	69.16	S 0.022 p. ct.; SiO_2 1.60 p. ct.; Al_2O_3 1.09 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 2 69 p. ct.	0.090	46
0.033	47.13	S 0.066 p. ct; SiO_2 27.99 p. ct; Al_2O_3 1.65 p. ct.; Mn. present; TiO_2 0.00; insoluble, 28.34 p. ct.; specific gravity, 3.996.	0.083	47.25	S 0.066 p. ct.; SiO_2 27.86 p. ct.; Al_2O_3 1.65 p. ct.; Mn. present; TiO_2 0.00; insoluble, 28.41 p. ct.	0.070	47
0.077	41.54	S 0.00; SiO_2 23.89 p. ct.; Al_2O_3 3.00 p. ct.; Mn. present; TiO_2 0.00; insoluble, 25.10 p. ct.; specific gravity, 4.206.	0.077	41.66	S 0.00; SiO_2 23.56 p. ct.; Al_2O_3 3.00 p. ct.; Mn. present; TiO_2 0.00; insoluble, 25.17 p. ct.	0.185	48
0.090	54.85	Specific gravity, 4.049	0.090	54.93		0.164	49
0.028	59.27	S 0.040 p. ct.; specific gravity, 4.329. Complete analysis.	0.028	59.44	S 0.040 p. ct	0.047	50
0.026	55.47	S 0.010 p. ct.; specific gravity, 4.575. Complete analysis.	0.026	55.80	S 0.010 p. ct	0.046	51
0.058	52.43	S 0.155 p. ct.; SiO_2 12.61 p. ct.; Al_2O_3 2.88 p. ct.; Mn. present; insoluble, 15.19 p. ct.; specific gravity, 4.044.	0.058	52.64	S 0.155 p. ct.; SiO_2 12.66 p. ct.; Al_2O_3 2.89 p. ct.; Mn. present; insoluble, 15.26.	0.111	52
0.140	61.71	S 0.078 p. ct.; SiO_2 3.77 p. ct.; Al_2O_3 1.75 p. ct.; Mn. present; TiO_2 0.00; insoluble, 4.82 p. ct.; specific gravity, 4.488.	0.140	61.85	S 0.078 p. ct.; SiO_2 3.78 p. ct.; Al_2O_3 1.75 p. ct.; Mn. present; TiO_2 0.00; insoluble, 4.83 p. ct.	0.227	53
0.096	54.88	S 0.093 p. ct.; SiO_2 11.17 p. ct.; Al_2O_3 2.40 p. ct.; Mn. present; TiO_2 0.00; insoluble, 12.40 p. ct.; specific gravity, 4.475.	0.096	55.16	S 0.09 p. ct.; SiO_2 11.23 p. ct.; Al_2O_3 2.41 p. ct.; Mn. present; TiO_2 0.00; insoluble, 12.46 p. ct.	0.175	54
0.063	49.05	S 0.043 p. ct.; SiO_2 21 83 p. ct.; Al_2O_3 2.70 p. ct.; Mn. 0.00; TiO_2 0.07 p. ct.; insoluble, 23.00 p. ct.; specific gravity, 3.722.	0.063	49.38	S 0.043 p. ct.; SiO_2 21.98 p. ct.; Al^2O_3 2.72 p. ct.; Mn. 0.00; TiO_2 0.07 p. ct.; insoluble, 23.15 p. ct.	0.128	55
0.082	57.52	S 0.059 p. ct.; SiO_2 8.55 p. ct.; Al_2O_3 2.70 p. ct.; Mn. present; TiO_2 0.00; insoluble, 10.80 p. ct.; specific gravity, 3.765.	0.082	57.65	S 0.059 p. ct.; SiO_2 8.57 p. ct.; Al_2O_3 2.71 p. ct.; Mn. present; TiO_2 0.00; insoluble, 10.82 p. ct.	0.143	56
0.056	59.34	S 0.057 p. ct.; SiO_2 7.23 p. ct.; Al_2O_3 3.04 p. ct.; Mn. present; TiO_2 0.00; insoluble, 9.12 p. ct.; specific gravity, 4.727.	0.056	59.59	S 0.057 p. ct.; SiO_2 7.26 p. ct.; Al_2O_3 3.04 p. ct.; Mn. present; TiO_2 0.00; insoluble, 9.16 p. ct.	0.094	57
0.047	61.97		0.047	62.08		0.076	58
0.188	61.90	Specific gravity, 4.592	0.188	62.06		0.304	59
0.128	59.95	S 0.055 p. ct.; SiO_2 5.18 p. ct.; Al_2O_3 3.43 p. ct.; Mn. present; TiO_2 0.00; insoluble, 6.55; specific gravity, 4.011.	0.128	60.12	S 0.055 p. ct.; SiO_2 5.19 p. ct.; Al_2O_3 3.44 p. ct.; Mn. present; TiO_2 0 00; insoluble, 6.57 p. ct.	0.214	60
0.064	59.94	S 0.003 p. ct.; SiO_2 6.26 p. ct.; Al_2O_3 1.64 p. ct.; Mn. present; TiO_2 0.09; insoluble, 7.74 p. ct.; specific gravity, 3.975.	0.064	60.08	S 0.003 p. ct.; SiO_2 6.27 p. ct.; Al_2O_3 1.64 p. ct.; Mn. present; TiO_2 0.00; insoluble, 7.76 p. ct.	0.107	61
0.043	50.54	S 0.055 p. ct.; SiO_2 23.66 p. ct; Al_2O_3 1.66 p. ct.; Mn. present; TiO_2 0.00; insoluble, 24.79 p. ct.; specific gravity, 4.065.	0.043	50.66	S 0.055 p. ct.; SiO_2 23.72 p. ct.; Al_2O_3 1.66 p. ct.; Mn. present; TiO_2 0.00; insoluble, 24.85 p. ct.	0.085	62
0.053	49.45	S 0.045 p. ct.; SiO_2 25.25 p. ct.; Al_2O_3 1.94 p. ct.; Mn. present; TiO_2 0.00; insoluble, 26.41 p. ct.	0.053	49.51	S 0.045 p. ct.; SiO_2 25.28 p. ct.; Al_2O_3 1.94 p. ct.; Mn. present; TiO_2 0.00; insoluble, 26.45 p. ct.	0.107	63
0.086	56.27	S 0.078 p. ct.; SiO_2 14.19 p. ct.; Al_2O_3 0.12 p. ct.; Mn. present; TiO_2 0.00; insoluble, 14.56 p. ct.; specific gravity, 4.104.	0 086	56.48	S 0.078 p. ct.; SiO_2 14 24 p. ct.; Al_2O_3 0.12 p. ct.; Mn. present; TiO_2 0.00; insoluble, 14.61 p. ct.	0.153	64
0.066	58.67	S 0.038 p. ct.; SiO_2 8.08 p. ct.; Al_2O_3 5.50 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 11.38 p. ct.; specific gravity, 4.527.	0.066	58.67	S 0.038 p. ct.; SiO_2 8.08 p. ct.; Al_2O_3 5.50 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 11.38 p. ct.	0.112	65
0.053	58.69	S 0.083 p. ct.; SiO_2 6.59 p. ct.; Al_2O_3 1.24 p. ct.; Mn. present; TiO_2 0.00; insoluble, 9.14 p. ct.; specific gravity, 4.673.	0.053	58.78	S 0.083 p. ct.; SiO_2 6.60 p. ct.; Al_2O_3 1.24 p. ct.; Mn. present; TiO_2 0.00; insoluble, 9.15 p. ct.	0.090	66
0.008	52.97	Specific gravity, 4.393	0.008	53.01		0.015	67
0.103	50.58	Specific gravity, 4.044	0.103	50.63		0.204	68
0.018	40.96	Specific gravity, 3.688	0.018	40.96		0.044	69
0.076	42.19	Specific gravity, 3.621	0.076	42.24		0.180	70
0.027	56.07	Specific gravity, 4.342	0.027	56.12		0.048	71
0.107	22.54	Specific gravity, 3.116	0.107	22.60		0.475	72
0.135	47.34	S 0.095 p. ct.; SiO_2 20.95 p. ct.; Al_2O_3 1.68 p. ct.; Mn. present; TiO_2 0.00; insoluble, 21.76 p. ct.; specific gravity, 3.814.	0.135	47.48	S 0.095 p. ct.; SiO_2 21.01 p. ct.; Al_2O_3 1.68 p. ct.; Mn. present; TiO_2 0.00; insoluble, 21.83 p. ct.	0.285	73
0.058	38.53	S 0.199 p. ct.; SiO_2 40.83 p. ct.; Al_2O_3 1.32 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 41.62 p. ct.; specific gravity, 4.973.	0.058	38.54	S 0.199 p. ct.; SiO_2 40.84 p. ct.; Al_2O_3 1.32 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 41.63 p. ct.	0.151	74
0.026	50.17	Specific gravity, 3.447	0.026	50.28		0.052	75
0.012	59.79	Specific gravity, 4.590	0.012	59.97		0.020	76
0.005	53.14	Specific gravity, 3.515	0.005	53.37		0.009	77
0.006	58.33	Specific gravity, 4.822	0.006	58.36		0.010	78
0.001	67.62	S 0.050 p. ct.; specific gravity, 5.036. Complete analysis.	0.001	67.62	S 0.50 p. ct	0.001	79
0.014	58.41	Specific gravity, 4.221	0.014	58.71		0.024	80
0.001	66.00	Specific gravity, 4.878	0.001	66.08		0.002	81
0.001	66.73	Specific gravity, 4.961	0.001	66.80		0.002	82
0.013	34.69	Specific gravity, 3.114	0.013	35.00		0.037	83
0.001	62.89	S 0.023 p. ct.; specific gravity, 4.371. Complete analysis.	0.001	62.95	S 0.023 p. ct	0.002	84
0.005	62.38	Specific gravity, 4.599	0.005	62.41		0.008	85
0.024	62.60	S 0.075 p. ct.; SiO_2 4.98 p. ct.; Al_2O_3 2.20 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.03 p. ct.; specific gravity, 4.745.	0.024	62.76	S 0 075 p. ct.; SiO_2 4.98 p. ct.; Al_2O_3 2.20 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.03 p. ct.	0.038	86
0.062	60.49	Specific gravity, 4.164	0.062	60.58		0.093	87
0.010	67.40	Specific gravity, 5.001	0.010	67 47		0.015	88

TABLE 25.—*Partial analyses of iron ores*—Continued.

LAKE SUPERIOR REGION—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
89	Gooch	Putnam	Specimens from bottom of main pit	Soft specular	58	Curry, Menominee county, Michigan
90	do	do	Specimens from near hanging-wall, main pit	do	59	do
91	Pitman	do	Across west side of east pit No. 1	Hematite	48	Saginaw, section 4 (Perkins), Menominee county, Michigan.
92	do	do	From east side of pit No. 3, near hanging-wall.	Specular	49	do
93	do	do	Across breast in east side of pit No. 3	Hematite	50	do
94	do	do	From west side of pit No. 2, from foot-wall to "horse."	Specular	51	do
95	do	do	From 1,700 tons of ore from pits Nos. 1 and 2	Hematite	52	do
96	do	do	From 2,000 tons of ore from pits Nos. 3 and 4	do	53	do
97	do	do	From east side of pit No. 4	do	54	do
98	Gooch	do	From 9-foot seam of ore, with bright greenish mineral.	Soft specular	42	Stephenson, Menominee county, Michigan.
99	do	do	In same stope, 2-foot seam, near hanging-wall	Specular	43	do
100	do	do	In same stope, 1-foot seam, near foot-wall	Soft specular	44	do
101	do	do	In same stope, 3-foot seam, between Nos. 43 and 44	do	45	do
102	do	do	From 75 tons of ore from shaft near property line	Specular	46	do
103	do	do	From 1,500 tons at mine	Soft specular	47	do
104	Pitman	do	Fragments from line of test pits, extending west from top of new incline.	Specular	31	Norway, Menominee county, Michigan.
105	do	do	From stope in pit No. 9, near hanging-wall	Conglomerate	32	do
106	do	do	From stope in pit No. 9, near foot-wall	Soft specular	33	do
107	do	do	From stope and broken ore in pit No. 8; "soft ore."	Hematite	34	do
108	do	do	Selected clippings of "hard ore" in pit No. 8	Specular	35	do
109	do	do	From "hard ore" on west side of pit No. 11	do	36	do
110	do	do	From stope and broken ore in pit No. 6; ore with yellowish green mineral.	Hematite	37	do
111	do	do	From stope in pit No. 6; average output	do	38	do
112	do	do	From west side of pit No. 4	do	39	do
113	do	do	From 75 tons of ore from pit No. 2	do	40	do
114	do	do	From 2,000 tons of ore from pits Nos. 3, 4, 5, 6, 7, 8, and 9.	do	41	do
115	do	do	From 10 car loads of ore from pit No. 11	do	55	do
116	do	Willis	From 6,000 tons at Cleveland	do	135	do
117	Gooch	Putnam	From near foot-wall in pit No. 2, stope west of shaft No. 2.	Soft specular	27	Cyclops, Menominee county, Michigan.
118	do	do	From near foot-wall, stope east of shaft No. 2	do	28	do
119	do	do	From breast of ore east end of pit No. 1, omitting band 10 feet wide next foot-wall.	do	29	do
120	do	do	From same breast, entirely across the ore	do	30	do
121	do	Willis	From 1,000 tons at Cleveland	do	117	do
122	Blair	Putnam	From stope, pit No. 2, third level	do	16	Quinnesec, Menominee county, Michigan.
123	do	do	From stope, pit No. 2, near hanging-wall; ore with greenish mineral.	do	17	do
124	do	do	From stope, pit No. 1, third level	do	18	do
125	do	do	Selected clippings of "hard ore" in pit No. 1	Soft specular and hematite.	19	do
126	do	do	From stope, pit No. 3, third level	Soft specular	20	do
127	do	do	From stope, pit No. 2, second level; "curly ore"	do	21	do
128	Gooch	Willis	From 4,000 tons at Cleveland	do	119	do
129	do	Putnam	From 750 tons of ore from shaft	do	68	McKenna, N. E. of S. E. Sec. 32, T. 40, R. 30, Menominee county, Michigan.
130	do	do	From 50 tons of ore from west test pit	do	69	McKenna, N. W. of S. E. Sec. 32, T. 40, R. 30, Menominee county, Michigan.
131	do	do	From near foot-wall at bottom of shaft No. 2	Hematite	25	Chapin, Menominee county, Michigan.
132	do	do	From 900 tons of ore from shaft No. 3	Soft specular	26	do
133	do	do	From a few tons of ore from shaft No. 1	Martite	26a	do
134	do	do	From 150 tons of ore at mine	Soft specular	24	Ludington, Menominee county, Michigan.
135	Blair	do	Across vein of "red ore" exposed in stripping	Hematite	22	Cornell, Menominee county, Michigan
136	do	do	Across vein of "blue ore" exposed in stripping	Soft specular	23	do
137	Gooch, Whitfield	do	From 700 tons of ore from 36-foot and 68-foot veins.	Specular	72	Commonwealth, Sec. 34, Marinette county, Wisconsin.
138	do	do	From sides of shaft in 14-foot vein	do	73	do
139	Gooch	do	From 200 tons of ore at shaft	Martite (?)	70	Commonwealth, Sec. 32, Marinette county, Wisconsin.
140	do	do	From trench 250 feet west of shaft, 5 feet below surface.	Hematite	71	do
141	Pitman	do	From fragments of ore near test shaft	Specular	74	Eagle (Florence), N. E. of S. E. Sec. 20, T. 40, R. 18, Marinette county, Wisconsin.
142	do	do	do	do	75	Eagle (Florence), S. W. of N. E. Sec. 20, T. 40, R. 18, Marinette county, Wisconsin.

TABLE 25.—*Partial analyses of iron ores*—Continued.

LAKE SUPERIOR REGION—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.008	67.53	Specific gravity, 5.173	0.008	67.63		0.012	89
0.005	67.03	Specific gravity, 4.998	0.005	67.10		0.007	90
0.005	59.86	Specific gravity, 3.969	0.005	59.90		0.008	91
0.006	59.47	Specific gravity, 4.224	0.006	59.53		0.010	92
0.008	51.71		0.008	51.86		0.015	93
0.032	63.25		0.032	63.26		0.051	94
0.007	57.37	Specific gravity, 4.377	0.007	57.43		0.012	95
0.006	56.91	Specific gravity, 4.109	0.006	56.97		0.010	96
0.004	59.39	Specific gravity, 4.632	0.004	59.43		0.007	97
0.094	56.47	Specific gravity, 4.360	0.094	56.48		0.166	98
0.068	63.53	Specific gravity, 4.705	0.068	63.68		0.107	99
0.086	52.59	Specific gravity, 4.271	0.086	52.60		0.163	100
0.048	61.48	Specific gravity, 4.083	0.048	61.55		0.078	101
0.069	52.78	S 0.004 p. ct.; specific gravity, 4.621. Complete analysis.	0.069	52.80	S 0.004 p. ct.	0.131	102
0.081	58.20	Specific gravity, 4.241	0.081	58.21		0.139	103
0.047	60.20	S 0.043 p. ct. Complete analysis, see p. 61.	0.047	60.20	S 0.043 p. ct.	0.078	104
0.035	49.56	Specific gravity, 3.936	0.035	49.58		0.071	105
0.030	59.72	Specific gravity, 3.830	0.030	59.75		0.050	106
0.045	52.97	Specific gravity, 3.647	0.045	53.53		0.085	107
0.014	58.35	Specific gravity, 4.675	0.014	58.39		0.024	108
0.019	59.26	Specific gravity, 4.570	0.019	59.27		0.032	109
0.084	62.73	S 0.058 p. ct.; specific gravity, 4.894. Complete analysis.	0.084	62.90	S 0.058 p. ct.	0.134	110
0.064	62.08	Specific gravity, 4.516	0.064	62.22		0.103	111
0.108	61.94	Specific gravity, 4.543	0.108	62.04		0.174	112
0.000	51.09	S 0.058 p. ct.; specific gravity, 3.926. Complete analysis.	0.000	51.14	S 0.058 p. ct.	0.000	113
0.068	56.12		0.068	56.18		0.121	114
0.041	57.39	Specific gravity, 4.399	0.041	57.44		0.071	115
0.057	55.49	S 0.071 p. ct.; SiO_2 16.03 p. ct.; Al_2O_3 1.73 p. ct.; Mn. present; TiO_2 0.00; insoluble, 16.86 p. ct.; specific gravity, 4.226.	0.057	55.63	S 0.071 p. ct.; SiO_2 16.07 p. ct.; Al_2O_3 1.73 p. ct.; Mn. present; TiO_2 0.00; insoluble, 16.90 p. ct.	0.103	116
0.013	53.58	Specific gravity, 3.777	0.013	53.71		0.024	117
0.012	29.58	Specific gravity, 2.971	0.012	29.79		0.041	118
0.012	65.90	Specific gravity, 4.933	0.012	65.95		0.018	119
0.013	64.38	Specific gravity, 3.478	0.013	64.48		0.020	120
0.013	62.05	S 0.066 p. ct.; SiO_2 5.01 p. ct.; Al_2O_3 2.50 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.31 p. ct.; specific gravity, 4.401.	0.013	62.27	S 0.066 p. ct.; SiO_2 5.00 p. ct.; Al_2O_3 2.50 p. ct.; Mn. 0.00; TiO_2 0.00; insoluble, 6.31 p. ct.	0.021	121
0.010	61.81	S 0.050 p. ct.; specific gravity, 4.204. Complete analysis.	0.010	61.93	S 0.050 p. ct.	0.016	122
0.009	55.49	S 0.059 p. ct.; specific gravity, 4.146. Complete analysis.	0.009	55.58	S 0.059 p. ct.	0.016	123
0.012	66.39	S 0.086 p. ct.; specific gravity, 4.701. Complete analysis.	0.012	66.40	S 0.086 p. ct.	0.018	124
0.005	64.47	S 0.050 p. ct.; specific gravity, 4.882. Complete analysis.	0.005	64.47	S 0.050 p. ct.	0.008	125
0.009	65.60	S 0.053 p. ct.; specific gravity, 4.518. Complete analysis.	0.009	65.63	S 0.053 p. ct.	0.014	126
0.008	64.38	Specific gravity, 4.331	0.008	64.52		0.012	127
0.038	63.49	S 0.008 p. ct.; SiO_2 5.52 p. ct.; Al_2O_3 1.87 p. ct.; Mn. trace; insoluble, 7.00 p. ct.; specific gravity, 5.006.	0.038	63.51	S 0.008 p. ct.; SiO_2 5.52 p. ct.; Al_2O_3 1.87 p. ct.; Mn. trace; insoluble, 7.00 p. ct.	0.060	128
0.061	54.39	S 0.00; specific gravity, 4.187. Complete analysis.	0.061	54.51	S 0.00	0.112	129
0.005	50.00		0.005	50.03		0.010	130
0.011	62.65	S 0.018 p. ct.; specific gravity, 4.534. Complete analysis.	0.011	62.77	S 0.018 p. ct.	0.018	131
0.007	65.97	S 0.001 p. ct.; specific gravity, 4.404. Complete analysis.	0.007	66.02	S 0.001 p. ct.	0.011	132
0.014	50.43		0.014	50.51		0.028	133
0.008	62.23	Specific gravity, 4.927	0.008	62.32		0.013	134
0.043	58.06	S 0.059 p. ct.; specific gravity, 4.694. Complete analysis.	0.043	58.12	S 0.059 p. ct.	0.074	135
0.032	56.99	S 0.078 p. ct. Complete analysis	0.032	57.08	S 0.078 p. ct.	0.056	136
0.205	60.25	S 0.000	0.205	60.38	S 0.000	0.340	137
0.239	57.84	Complete analysis of 72 and 73 together	0.239	57.95		0.413	138
0.172	59.61	S 0.370 p. ct.; specific gravity, 4.980. Complete analysis.	0.172	59.64	S 0.370 p. ct.	0.288	139
0.041	46.21	Specific gravity, 4.269	0.042	47.94		0.088	140
0.369	54.91	Specific gravity, 4.511	0.369	54.98		0.672	141
0.285	59.17	Specific gravity, 4.186	0.285	59.17		0.482	142

TABLE 25.—*Partial analyses of iron ores*—Continued.

ALABAMA.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	White	Chauvenet	From 100 tons from pit	Fossil	201	De Bardeleben, Sec. 6, T. 18, R. 2 W., Jefferson county.
2	do	do	From face of ore near end of entry seam No. 1	do	202	Eureka, Sec. 21, T. 18, R. 3 W., Jefferson county.
3	do	do	From face of seam No. 2 (3-foot vein)	do	203	do
4	King	do	From stock pile at furnace; a mixture of ores from seams Nos. 1 and 2.	do	205	do
5	do	do	From outcrops, seams Nos. 1 and 2	do	204	Outcrop, Sec. 30, T. 18, R. 3 W., Jefferson county.
6	do	do	From stock pile at Oxmoor furnace	Carbonate (burnt)	207	Newcastle Coal Co., Sec. 17, T. 16, R. 2 W., Jefferson county.
7	do	do	From face of Finch seam of ore on side-wall, north end of main entry.	Carbonate	208	do
8	do	do	From face of 12½-inch seam of ore in same entry	do	209	do
9	White	do	From outcrop in mill-race	Fossil	210	Outcrop, Sec. 30, T. 15, R. 1 W., Jefferson county.
10	do	do	From outcrop on creek	do	211	do
11	do	do	From scattered surface fragments	Limonite	212	Van's land, Sec. 9, T. 16, R. 1 W., Jefferson county.
12	do	do	From outcrop of 4-foot seam on "Hickman's place."	Fossil	213	Outcrop, Sec. 10, T. 16, R. 1 W., Jefferson county.
13	King	do	From outcrop on "Hickman's place"	do	214	Outcrop, Sec. 2, T. 16, R. 1 W., Jefferson county
14	do	do	From outcrops on road, "Hickman's place"	do	215	Outcrop, Sec. 15, T. 16, R. 1 W., Jefferson county
15	White	do	From surface fragments near old pit	Limonite	221	O'd Ore Pit, Sec. 25, T. 17, R. 1 W., Jefferson county.
16	King	do	From pile of ore near old workings	Fossil	222	Irondale, T. 17, R. 2 W., Jefferson county.
17	White	do	From face of ore 135 feet thick in prospecting pit on northwest slope of Red mountain.	do	260	M. L. Potter's property, Sec. 11, T. 19, R. 4 W., Jefferson county.
18	do	do	From seam of hard ore between upper and lower soft ores.	do	261	M. L. Potter's property, Sec. 2, T. 19, R. 4 W., Jefferson county.
19	King	do	From outcrops of two seams above main entry to mine.	do	216	Woodall, Sec. 28, T. 14, R. 2 E., Saint Clair county.
20	White	do	From face of 3- to 3½-foot seam	do	217	Saint Clair, Sec. 27, T. 14, R. 2 E., Saint Clair county.
21	do	do	From face of lower seam 110 feet below No. 217	do	218	do
22	do	do	From face of seam on left of main tramway	do	219	Aderholt, Sec. 23, T. 14, R. 2 E., Saint Clair county.
23	do	do	From stock pile at railroad	do	220	do
24	King	do	From lumps of ore from prospecting pits	Limonite	223	Strickland bed, Secs. 10 and 11, T. 21, R. 6 W., Bibb county.
25	do	do	From exposure of bed on north side of branch, and from four prospecting pits along slope of hill.	do	224	Edward's bed, Secs. 10 and 11, T. 21, R. 6 W., Bibb county.
26	White	do	From outcropping bowlders along east side of creek.	do	225	Edward's, Sec. 3, T. 21, R. 6, W., Bibb county.
27	do	do	From loose fragments from pit	do	226	De Bardeleben, Sec. 11, T. 21, R. 6 W., Bibb county.
28	King	do	From two prospecting pits 400 yards apart	do	231	Ray's land, Sec. 15, T. 21, R. 6 W., Bibb county.
29	do	do	From fragments from prospecting pit	do	232	Ray's land, Sec. 16, T. 21, R. 6 W., Bibb county.
30	White	do	From old workings on west side of Montevallo road.	do	234	Brierfield, Sec. 21, T. 24, R. 11 E., Bibb county.
31	King	do	From 100 tons at Oxmoor furnace	do	206	Shelby Coal Co., Sec. 1, T. 21, R. 6 W., Tuscaloosa county.
32	White	do	From surface lumps from prospecting pit	Fossil	227	Shamblin & Dickey tract, Sec. 34, T. 20, R. 6 W., Tuscaloosa county.
33	do	do	From three openings, ¼ mile apart, along continuous ridge of ore.	Limonite	228	Pioneer Iron Co., Sec. 30, T. 20, R. 5 W., Tuscaloosa county.
34	do	do	From three openings 300 yards apart	do	229	Tuscaloosa Iron Co., Sec. 29, T. 20, R. 5 W., Tuscaloosa county.
35	do	do	From lumps in place of lower bed, south by west of washing machine.	do	230	Eureka, Sec. 2, T. 21, R. 6 W., Tuscaloosa county.
36	King	do	From outcrop on northeast side of branch	do	233	Woodward property, Sec. 10, T. 21, R. 6 W., Tuscaloosa county.
37	White	do	From washed ore at washer	do	235	Shelby, Sec. 13, T. 22, R. 1 W., Shelby county.
38	do	do	From pile of burnt ore at Shelby furnace	Limonite (burnt)	236	do
39	King	do	From face of "big ledge" at Shelby bank	Limonite	237	do
40	do	do	From cars at Alabama furnace	do	238	Talladega, Sec. 20, T. 18, R. 5 E., Talladega county.
41	do	do	From stock pile at Alabama furnace	do	239	Clifton bank, Sec. 26, T. 18, R. 6 E., Talladega county.
42	White	do	From 100 tons at mine	do	241	do
43	do	do	From 2 pits, 100 yards apart, on bed No. 6	do	242	do
44	King	do	From fragments near old pit	do	243	do
45	White	do	From bowlders of ore in working face of open cut.	do	240	Alabama furnace, S. 17, T. 17, R. 7 E., Talladega county.
46	King	do	From cars at Woodstock furnaces	do	244	Sparks bank, T. 19, R. 4 E., Talladega county.
47	do	do	From 10 tons of ore on cars at Woodstock furnaces.	do	245	Side bank, T. 19, R. 4 E., Talladega county.
48	do	do	From 3 car-loads at Woodstock furnaces; "clay ore."	do	246	Glover bank, Sec. 21, T. 15, R. 8 E., Calhoun county.
49	do	do	From ore in 2 adjoining pits	do	247	Old Oxford bank, Sec. 7, T. 15, R. 8 E., Calhoun county.
50	White	do		do	259	do
51	King	do	On working face	do	248	Skinner bank, T. 15, R. 8 E., Calhoun county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

ALABAMA.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.200	46.80		0.201	47.05		0.429	1
0.219	51.25	S 0.140 p. ct. Complete analysis	0.220	51.60	S 0.140 p. ct	0.426	2
0.519	50.40		0.521	50.64		1.030	3
0.225	50.89		0.226	51.17		0.442	4
0.067	56.69		0.067	56.87		0.118	5
0.228	43.49		0.228	43.54		0.524	6
0.115	8.38	TiO_2 absent	0.116	8.45	TiO_2 absent	1.372	7
0.194	29.48		0.195	29.58		0.658	8
0.324	36.58		0.325	36.73		0.886	9
0.061	28.22		0.021	28.42		0.216	10
0.301	51.94		0.302	52.12		0.780	11
0.085	59.99		0.085	60.27		0.142	12
0.102	18.18		0.102	18.23		0.561	13
0.051	44.16		0.051	44.40		0.115	14
0.057	52.30		0.057	52.51		0.109	15
0.161	36.41		0.161	36.51		0.442	16
0.152	54.15	Specific gravity, 4.177	0.153	54.50		0.281	17
0.319	40.04	Specific gravity, 3.694	0.320	40.12		0.797	18
0.292	48.68		0.295	49.11		0.600	19
0.261	53.28		0.265	54.07		0.490	20
0.435	49.49		0.441	50.17		0.879	21
0.409	45.45		0.414	45.96		0.900	22
0.348	48.40		0.353	49.09		0.719	23
0.944	48.16		0.954	48.66		1.960	24
0.878	41.48		0.889	41.68		2.117	25
0.764	47.11	Specific gravity, 3.509	0.769	47.40		1.622	26
0.221	46.54	Specific gravity, 3.483	0.223	46.94		0.475	27
0.928	47.77	Specific gravity, 3.502	0.932	48.22		1.932	28
0.266	54.26	Specific gravity, 3.720	0.267	54.54		0.490	29
0.265	49.12	Specific gravity, 3.614	0.266	49.36		0.540	30
0.259	44.12		0.262	44.57		0.587	31
0.048	49.49	Specific gravity, 3.958	0.048	49.80		0.097	32
0.491	48.59	Specific gravity, 3.544	0.495	49.03		1.010	33
1.021	48.12	Specific gravity, 3.488	1.032	48.63		2.122	34
0.179	46.59	S 0.318 p. ct.; specific gravity, 3.458. Complete analysis.	0.181	47.00	S 0.320 p. ct.	0.385	35
0.444	56.12	Specific gravity, 3.771	0.446	56.35		0.791	36
0.241	52.82	S 0.139 p. ct.; specific gravity, 3.725. Complete analysis.	0.243	53.26	S 0.140 p. ct	0.456	37
0.282	53.92	Specific gravity, 3.763	0.284	54.38		0.523	38
0.137	49.64	Specific gravity, 3.617	0.138	50.18		0.276	39
0.181	54.23	Specific gravity, 3.814	0.182	54.44		0.334	40
0.047	52.40	Specific gravity, 3.746	0.047	52.71		0.090	41
0.011	48.74	Specific gravity, 3.668	0.011	49.00		0.023	42
0.041	52.22	S 0.109 p. ct.; specific gravity, 3.732. Complete analysis.	0.041	52.51	S 0.110 p. ct	0.078	43
0.100	51.98	Specific gravity, 3.727	0.100	52.20		0.193	44
0.912	53.45	Specific gravity, 3.707	0.918	53.83		1.706	45
0.118	54.09	Specific gravity, 3.804	0.118	54.16		0.218	46
0.149	47.12	Specific gravity, 3.433	0.151	47.69		0.316	47
0.048	45.37	Specific gravity, 3.510	0.048			0.105	48
0.147	49.92	Specific gravity, 3.711	0.148	50.11		0.296	49
0.068	53.72	Specific gravity, 3.844	0.068	53.83		0.127	50
0.031	48.62	Specific gravity, 3.671	0.318	49.02		0.063	51

TABLE 25.—*Partial analyses of iron ores*—Continued.

ALABAMA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
52	White	Chauvenet	From washer at mine	Limonite	249	Washer bank, Sec. 7, T. 15, R. 8 E., Calhoun county.
53	King	do	From stock pile of 2,000 tons at Tecumseh furnace.	do	256	Jacksonville, Sec. 12, T. 14, R. 8 E., Calhoun county.
54	White	do	From outcropping bowlders southeast of furnace.	do	250	Stonewall (lower bank), Sec. 15, T. 12, R. 11 E., Cherokee county.
55	do	do	From three wagon loads	do	251	Stonewall (upper bank), Sec. 15, T. 12, R. 11 E., Cherokee county.
56	do	do	From wagons direct from bank	do	252	Tecumseh Iron Company, Sec. 18, T. 12, R. 12 E., Cherokee county.
57	do	do	do	do	253	Tecumseh Iron Company, Sec. 29, T. 12, R. 12 E., Cherokee county.
58	do	do	From unlighted roast heap, 2,000 to 3,000 tons	do	254	Tecumseh Iron Company, T. 12, R. 12 E., Cherokee county.
59	King	do	From all parts of large open cut	do	255	Tecumseh Iron Company, Sec. 30, T. 12, R. 12 E., Cherokee county.
60	do	do	From loose lumps thrown from newly opened pit.	do	257	Hardin bank, Sec. 32, T. 11, R. 11 E., Cherokee county.
61	White	do	From three pits on the bank	do	258	Furnace bank, Sec. 5, T. 12, R. 11 E., Cherokee county.
62	do	do	From stock pile at furnace	Fossil	262	Round Mountain furnace bank, Sec. 33, T. 9, R. 9 E., Cherokee county.
63	King	do	From 2 tons left at blowing out of furnace	Fossil (roasted)	263	do
64	do	do	From four pits on bank	Fossil	264	do
65	do	do	From tunnel on crown of vein	do	265	Attala, Sec. 34, T. 11, R. 5 E., Etowah county.
66	do	do	From 800 to 1,000 tons on stock pile	do	266	do
67	do	do	From tunneled ore at mine	do	267	do
68	do	do	From stock pile, 150 tons of ore from tunnel only	do	268	Attala (Rising Fawn), Sec. 34, T. 11, R. 5 E., Etowah county.
69	do	do	On stock pile at South Pittsburgh furnaces	do	270	Attala, Sec. 34, T. 11, R. 5 E., Etowah county.
70	do	do	do	do	271	do
71	Pitman	Willis	From eastern slope of ridge; surface pieces	Limonite	1201	Near Pendergrass property, Oxford, Calhoun county.
72	do	do	From outcrop	do	1202	do
73	do	do	From surface fragments in plowed field	Magnetite	1203	J. M. Kennedy's land, Oxford, Clay county.
74	do	do	From surface pieces in the road	Limonite	1204	T. B. Fleming's land, Russellville, Franklin county.
75	do	do	From surface fragments in the field	do	1205	Dr. Sevier's land, Russellville, Franklin county.
76	do	do	From bank	Bog	1206	Old Iron Works, Vernon, Lamar county.
77	do	do	From pile of ore roasted 12 years ago	Bog (roasted)	1207	do

CALIFORNIA.

1	Whitfield	Putnam	From 30 tons of ore near outcrop	Magnetite	1170	Clipper Gap, Clipper Gap station, Placer county.
2	do	do	From a few tons of ore from test pit ¼ mile southwest of furnace.	do	1171	do
3	do	do	From 350 tons of ore at mine	Limonite	1172	Clipper Gap Hematite, Clipper Gap station, Placer county.
4	do	do	Two sacks of ore in Mr. Adams' office in San Francisco.	Hematite	1173	Adams, near Saint Helena, Napa county.

COLORADO.

1	Whitfield	Putnam	From old stock pile near furnace, and pieces from surface of plains in neighborhood.	Limonite	1104	Near Marshall's coal mine, New Boulder, Boulder county.
2	do	do	Selected pieces of bright black-surfaced ore from Caribou Hill.	Magnetite	1105	Caribou Hill, near Caribou, Boulder county.
3	do	do	From dump near western opening	do	1106	do
4	do	do	Outcrop, western opening	Magnetite (?)	1107	Jefferson County iron mines, near Morrison, Jefferson county.
5	do	do	From face of lower drift	Magnetite	1108	Ainsworth, near Placer station, Costilla county.
6	do	do	From face of upper drift	do	1108a	do
7	do	do	In lower drift	Magnetite (altered)	1109	Stoddard, near Placer station, Costilla county.
8	do	do	From about 500 tons of ore at bottom of incline; from the upper drift and open cut.	Magnetite	1110	do
9	do	do	From small seam of ore above the El Mora coal seam.	Carbonate and limonite	1111	El Mora coal mine, near Trinidad, Las Animas county.
10	do	do	Lump of spathic ore on plains 3 miles south of Walsenburgh.	Carbonate	1112	Plains near Walsenburgh, Huerfano county.
11	do	do	On plains 3 miles south of Walsenburgh	do	1113	do
12	King	do	From southwestern part of hill	Magnetite	1114	"Iron Mountain", "Grape Cr.", near Pine Cr., Fremont county.
13	do	do	From south end of hill on vein No. 4	do	1115	do
14	do	do	From south end of hill on vein No. 6	do	1116	do
15	do	do	From near shaft on vein No. 3	do	1117	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

ALABAMA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.113	52.14	Specific gravity, 3.728	0.114	52.46		0.217	52
0.541	40.64	Specific gravity, 3.458	0.545	40.91		1.331	53
0.676	41.45	Specific gravity, 3.716	0.681	41.73		1.631	54
0.301	42.52	Specific gravity, 3.484	0.302	42.60		0.708	55
0.108	50.64	S 0.179 p. ct.; specific gravity, 3.706. Complete analysis.	0.108	50.25	S 0.180 p. ct	0.215	56
0.584	48.44	Specific gravity, 3.584	0.589	48.83		1.206	57
0.908	51.50	Specific gravity, 3.662	0.916	51.96		1.761	58
0.838	52.67	Specific gravity, 3.711	0.846	52.54		1.609	59
0.749	54.15	Specific gravity, 3.778	0.754	54.49		1.383	60
0.342	54.96	Specific gravity, 3.829	0.343	55.16		0.622	61
0.084	59.03		0.084	59.20		0.142	62
0.104	58.39	Specific gravity, 4.425	0.105	58.74		0.178	63
0.098	57.18	Specific gravity, 4.326	0.099	57.58		0.171	64
0.640	54.48	Specific gravity, 4.109	0.645	54.89		1.174	65
0.487	53.78		0.488	53.91		0.906	66
0.641	53.60	S 0.085 p. ct.; specific gravity, 4.110. Complete analysis.	0.648	54.15	S 0.086 p. ct	1.197	67
0.430	56.04	Specific gravity, 4.201	0.433	56.42		0.767	68
0.412	45.98	Specific gravity, 3.577	0.420	46.87		0.896	69
0.375	31.30	Specific gravity, 3.386	0.377	31.49		1.198	70
0.423	58.29		0.425	58.63		0.726	71
0.184	54.86		0.185	55.19		0.335	72
0.064	58.51	SiO_2 10.47 p. ct.; Mn. present; TiO_2 0.00; insoluble, 15.68 p. ct.	0.064	58.60	SiO_2 10.47 p. ct.; Mn. present; TiO_2 0.00; insoluble, 15.68 p. ct.	0.109	73
0.590	55.60		0.596	56.17		1.061	74
0.527	56.89		0.530	57.23		0.926	75
0.191	55.04		0.194	55.85		0.347	76
0.265	62.65	TiO_2 absent	0.265	62.72	TiO_2 absent	0.423	77

CALIFORNIA.

0.068	67.68		0.068	67.84		0.100	1
0.047	64.98		0.047	65.19		0.072	2
0.178	53.41		0.183	55.01		0.333	3
1.870	47.45		1.870	48.05		3.941	4

COLORADO.

0.305	47.80		0.309	48.54		0.637	1
0.017	59.04	TiO_2 present	0.017	59.04	TiO_2 present	0.029	2
0.022	35.35	do	0.022	35.35	do	0.062	3
0.069	20.56		0.069	20.58		0.336	4
0.016	59.23		0.016	59.44		0.027	5
0.008	47.24		0.008	47.39		0.017	6
0.039	55.56		0.039	56.04		0.070	7
0.059	52.58		0.059	52.86		0.112	8
0.047	51.46		0.047	53.02		0.091	9
1.190	27.71	CO_2 present	1.196	27.86	CO_2 present	4.258	10
0.556	15.63	do	0.561	15.66	do	3.557	11
0.025	48.89	Mn. absent; TiO_2 11.99 p. ct	0.025	49.09	Mn. absent; TiO_2 12.04 p. ct	0.051	12
0.026	48.18	Mn. present; TiO_2 12.92 p. ct	0.026	48.25	Mn. present; TiO_2 12.94 p. ct	0.054	13
0.037	46.61	Mn. present; TiO_2 11.61 p. ct	0.037	46.70	Mn. present; TiO_2 11.63 p. ct	0.079	14
0.011	48.85	Mn. present; TiO_2 12.73 p. ct	0.011	48.89	Mn. present; TiO_2 12.74 p. ct	0.023	15

TABLE 25.—*Partial analyses of iron ores*—Continued.

COLORADO—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
16	King	Putnam	From near top of hill on vein No. 4	Magnetite	1118	"Iron Mountain", "Grape Cr.", near Pine Cr., Frémont county.
17	do	do	From near top of hill on vein No. 5	do	1119	do
18	do	do	From near top of hill on vein No. 7	do	1120	do
19	do	do	From dump from shaft	Limonite	1121	Beehive, near Villa Grove, Saguache county.
20	do	do	From dump near shaft	do	1122	Prospect lode, near Villa Grove, Saguache county.
21	do	do	Selected pieces from dump	do	1123	Poorman's lode, near Villa Grove, Saguache county.
22	do	do	From along side of drift	do	1124	McClellan lode, near Villa Grove, Saguache county.
23	do	do	From dump	Hematite	1125	Saguache lode, near Villa Grove, Saguache county.
24	Whitfield	do	In bottom of slope 68 feet from surface, on dip of vein.	Magnetite	1176	Calumet, near South Arkansas, Chaffee county.
25	do	do	From prospect hole	do	1176x	Hecla, near South Arkansas, Chaffee county.
26	King	do	Near the south slope	Specular hematite	1126	Breece, Leadville, Lake county
27	do	do	Stock pile ore, all from south slope	do	1127	do
28	do	do	From upper shaft	do	1128	do
29	do	do	Selected from a few tons of ore at the mine	Manganiferous (black ore).	1129	Amie, Leadville, Lake county
30	do	do	Selected from a few tons of ore at the mine	Limonite (red ore)	1130	do
31	do	do	From 500 tons at Grant's smelter	Limonite (red and black ore).	1131	do
32	do	do	From 25 tons of crushed ore at Holland smelter	Magnetite	1132	Holland smelter, near Hamilton, Park county.

CONNECTICUT.

1	Whitfield	Putnam	From mine	Brecciated ore	772	Kent, Kent, Litchfield county
2	do	do	From 100 tons of rock ore at mine	Limonite	773	do
3	do	do	From 300 tons of washed ore at mine	do	774	do
4	do	do	From 30 tons washed ore from Adams tract at mine.	do	775	Chatfield, Salisbury, Litchfield county
5	do	do	From 40 tons washed ore from Reed tract at mine.	do	776	do
6	do	do	From 45 tons washed ore from Fitch tract at mine.	do	777	do
7	do	do	From rock ore from Reed tract at mine	do	778	do
8	do	do	From rock ore from Fitch tract at mine	do	779	do
9	do	do		"Slacks"	780	do
10	do	do	From selected pieces at mine	Limonite (crystallized)	781	Brookpit (Old Hill), Salisbury, Litchfield county.
11	do	do	From selected pieces of stalactic ore at mine	Limonite	782	do
12	do	do	From 5 cars of rock ore at mine	do	783	do
13	do	do	From 3 cars of washed ore at mine	do	784	do
14	do	do	From 20 tons of washed ore at mine	do	785	Davis, Salisbury, Litchfield county
15	do	do	From 15 tons "Manganese ore" at mine	"Manganese"	786	do
16	do	do	Earthy manganese from mine	do	787	do
17	do	do	From a few tons rock ore at mine	Limonite	788	do
18	do	do	From 50 tons rock ore at new mine	do	789	Scoville, Salisbury, Litchfield county

DELAWARE.

1	Richmond	Benton	From ore ready for shipment at railroad	Limonite	1025	Chestnut Hill, Chestnut Hill, New Castle county.
2	do	do	do	do	1026	East Chestnut Hill, Chestnut Hill, New Castle county.
3	do	do	From several tons unwashed ore at washer; from southerly part of mine.	do	1027	Iron Hill, Iron Hill, New Castle county
4	do	do	From several tons washed ore at furnace	Limonite (washed)	1028	do

GEORGIA.

1	White	Willis	From one wagon load	Limonite	418	Jarrett's bank, near Morgantown, Fannin county.
2	do	do	From pile of roasted ore	do	419	do
3	do	do	Stamped, washed, and roasted ore	do	420	do
4	do	do	From exposure of ore in pit	do	421	Judge Donaldson's, near Canton, Cherokee county.
5	do	do	Bluish earth accompanying ore	do	422	do
6	do	do	Hard compact ore from the vein at bank	do	423	Bartow furnace bank, near Bartow furnace, Cartersville, Bartow county.
7	do	do	Soft friable ore, from same banks as No. 423	do	424	do
8	do	do	Angular fragments of hard ore, from same banks as Nos. 423 and 424.	do	425	do
9	do	do	From pit	do	426	Bartow furnace bank, directly north of Bartow furnace, Cartersville, Bartow county.
10	do	do	From vein in small pit	do	427	Wheeler bank (northern end), Cartersville, Bartow county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

COLORADO—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.040	46.05	Mn. present; TiO_2 13.84 p. ct	0.040	46.15	Mn. present; TiO_2 13.87 p. ct.	0.087	16
0.039	47.01	Mn. present; TiO_2 14.86 p. ct	0.039	47.04	Mn. present; TiO_2 14.87 p. ct.	0.083	17
0.026	47.42	Mn. present; TiO_2 13.04 p. ct	0.026	47.46	Mn. present; TiO_2 13.05 p. ct.	0.055	18
0.026	54.47	Mn. present	0.026	54.71	Mn. present	0.048	19
0.058	55.56	do	0.058	55.84	do	0.104	20
0.055	51.64	Mn. trace	0.056	52.47	Mn. trace	0.106	21
0.034	55.61	Mn. present	0.034	55.87	Mn. present	0.061	22
0.045	45.39	do	0.046	46.33	do	0.099	23
0.026	49.23		0.026	49.33		0.053	24
0.008	48.03		0.008	48.03		0.017	25
0.017	64.35		0.017	64.52		0.026	26
0.038	61.51		0.038	61.73		0.062	27
0.024	63.25		0.024	63.47		0.038	28
0.058	40.95	TiO_2 absent; Mn. present	0.058	41.20	TiO_2 absent; Mn. present	0.142	29
0.076	50.20	do	0.077	50.75	do	0.151	30
0.049	44.38	do	0.049	44.76	do	0.110	31
0.040	63.01	do	0.040	63.03	do	0.063	32

CONNECTICUT.

0.196	30.82		0.197	30.97		0.636	1
0.315	53.02		0.318	53.52		0.594	2
0.353	50.48		0.356	50.97		0.699	3
0.128	35.10		0.129	35.42		0.365	4
0.113	40.03		0.114	40.34		0.282	5
0.100	44.04		0.101	44.43		0.227	6
0.103	44.38	Mn. present; BaO present	0.104	44.84	Mn. present; BaO present	0.232	7
0.120	48.02		0.121	48.58		0.250	8
0.071	15.96		0.071	16.06		0.445	9
0.101	55.37		0.102	55.91		0.182	10
0.452	57.00		0.458	57.76		0.793	11
0.196	50.12	S 0.150 p. ct. Complete analysis	0.198	50.53	S 0.151 p. ct	0.393	12
0.162	44.80		0.163	45.11		0.362	13
0.059	44.59		0.060	45.08		0.132	14
0.045	27.46	Mn. 26.60 p. ct	0.045	27.74	Mn. 26.87 p. ct.	0.164	15
0.068	2.24	Mn. 25.81 p. ct	0.069	2.27	Mn. 26.19 p. ct.		16
0.073	41.55		0.074	42.19		0.176	17
1.000	54.47		1.009	54.94		1.836	18

DELAWARE.

0.095	43.11		0.097	43.83		0.220	1
0.313	37.13		0.322	38.20		0.843	2
0.063	51.27		0.064	51.99		0.123	3
0.096	52.60		0.098	53.62		0.183	4

GEORGIA.

0.284	53.41	Specific gravity, 3.708	0.287	53.92		0.532	1
0.265	57.83		0.276	60.23		0.458	2
0.331	57.40	Specific gravity, 4.121	0.336	58.25		0.577	3
0.660	52.70	Specific gravity, 3.708	0.667	53.29		1.252	4
0.139	48.47		0.140	48.86		0.287	5
1.911	50.57		1.952	51.67		3.779	6
0.488	53.67	Specific gravity, 3.871	0.495	54.49		0.909	7
0.319	40.35		0.321	40.61		0.791	8
0.332	52.46	Specific gravity, 3.739	0.335	52.91		0.633	9
0.802	56.57	Specific gravity, 3.778	0.807	56.92		1.418	10

TABLE 25.—*Partial analyses of iron ores*—Continued.

GEORGIA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
11	White	Willis	From large open cut	Limonite	428	Wheeler bank, northeast of Wheeler's house, Cartersville, Bartow county.
12	do	do	Hard ore forming walls of cavities	do	429	Crow bank, northeast of Wheeler's house, Cartersville, Bartow county.
13	do	do	Soft ore from same bank as No. 429	do	430	do
14	do	do	From exposure of ore in bank	do	431	Irish bank, northeast of Wheeler's house, Cartersville, Bartow county.
15	do	do	do	do	432	Black bank, northeast of Wheeler's house, Cartersville, Bartow county.
16	do	do	From pile of ore at Diamond furnace	do	433	Wildcat bank, near Cartersville, Bartow county.
17	do	do	At Diamond furnace, roasted ore	do	434	do
18	do	do	From vein of ore in bank	do	435	Peach tree bank, Cartersville, Bartow county.
19	King	do	From pile mined for Diamond furnace	do	436	Big bank, Cartersville, Bartow county.
20	do	do	From 3 tons of ore	do	437	Connor bank, Cartersville, Bartow county.
21	do	do	From bank	do	438	Burford bank, Cartersville, Bartow county.
22	do	do	do	do	439	Munford bank, Cartersville, Bartow county.
23	do	do	do	do	440	Giton bank, Cartersville, Bartow county.
24	do	do	do	Specular	441	Gray ore bank, Etowah river, Bartow county.
25	do	do	From vein in new opening	do	472	do
26	do	do	From few pieces by side of test trench	Limonite	473	Caldwell bank, near Kingston, Bartow county.
27	White	do	From eastern opening	do	442	Wood's bank, near Cherokee furnace, Cedartown, Polk county.
28	do	do	From southern opening	do	443	do
29	do	do	From western opening	do	444	do
30	do	do	From bank	do	445	Peck bank, near Cherokee furnace, Cedartown, Polk county.
31	do	do	From 10 tons at Cherokee furnace	do	446	Phillips bank, near Cherokee furnace, Cedartown, Polk county.
32	do	do	From extensive outcrop	do	447	Fisher's Creek bank, Cedartown, Polk county.
33	do	do	From stock pile at furnace	do	448	Pennington bank, Prior's station, Polk county.
34	do	do	From ledge of ore	do	450	Folger bank, Prior's station, Polk county.
35	do	do	From small opening on vein	do	451	Snake Pond bank, Prior's station, Polk county.
36	do	do	From small exposure in vein	do	452	do
37	do	do	From stock pile at furnace	do	449	Alloway bank, Etna furnace, Polk county.
38	King	Chauvenet	From stock pile at South Pittsburgh furnace	do	269	S. B. Lowe's, Folger Switch, Polk county.
39	White	Willis	From opening in western face of hill	do	453	Ridge Valley furnace banks, near Rome, Floyd county.
40	do	do	From opening on hill farthest from furnace	do	454	do
41	do	do	From compact slaty ore near old pit	do	455	do
42	do	do	From ½ ton of ore at bank	do	456	Flower Branch bank, near Rome, Floyd county.
43	King	do	From exposure of ore in old pit	do	474	Snake Creek bank, Snake Creek Gap, Walker county.
44	do	do	From fragments of ore from test pit	Fossil	475	Holland's, Trickum, Whitfield county.
45	do	do	From surface fragments	Limonite	476	J. R. Harris, near Spring Place, Murray county.
46	do	do	From fragments near old shaft	do	477	Garrison Potect's, Alaculsie valley, Murray county.
47	Whitfield	do	From pile of ore near test pit	do	478	Calico bank, Alaculsie valley, Murray county.

KENTUCKY.

1	White	Chauvenet	From lumps of ore from main vein	Carbonate	583	Bath furnace banks, Olympian Springs, Bath county.
2	do	do	From three banks within 3 miles of furnace	do	584	do
3	do	do	From southwest slope of hill	Limonite	585	Old slate bank, near Owingsville, Bath county.
4	do	do	From whole face of vein	Carbonate	586	Anderson bank, Estill furnace, Powell county.
5	King	do	From small pit recently opened	do	587	do
6	do	do	From stock pile of 600 tons unburnt ore at furnace.	do	588	Estill furnace banks, Estill county
7	do	do	From all parts of bank	Limonite	589	Schoolhouse bank, Center furnace, Lyon county.
8	do	do	From all working faces	do	590	Fulton bank, Center furnace, Lyon county.
9	do	do	From roof and wall of northeast side of room	do	591	Center bank, Center furnace, Lyon county.
10	do	do	From exposures of ore in main banks	do	592	Trigg furnace banks, Trigg county

TABLE 25.—*Partial analyses of iron ores*—Continued.

GEORGIA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
1.612	51.62		1.643	52.62		3.123	11
1.124	56.24	Specific gravity, 3.465	1.138	56.95		1.999	12
0.502	59.20	Specific gravity, 4.201	0.511	60.29		0.848	13
0.540	57.42		0.544	57.88		0.940	14
0.752	54.71		0.757	55.10		1.374	15
0.668	50.64	S 0.179 p. ct.; specific gravity, 3.634. Complete analysis.	0.672	50.96	S 0.180 p. ct	1.319	16
0.755	63.40	Specific gravity, 4.322	0.763	64.06		1.191	17
0.442	59.16		0.448	60.00		0.747	18
0.649	54.84	Mn. 0.12 p. ct	0.657	55.56	Mn. 0.12 p. ct	1.183	19
0.112	60.12		0.113	60.75		0.186	20
0.201	54.36	Mn. 0.35 p. ct.; specific gravity, 3.848	0.202	54.61	Mn. 0.35 p. ct	0.370	21
0.330	55.69	S 0.008 p. ct.; specific gravity, 3.863. Complete analysis.	0.331	55.87	S 0.008 p. ct	0.592	22
0.457	48.90	Mn. 1.61 p. ct.; specific gravity, 3.680	0.461	49.34	Mn. 1.61 p. ct	0.935	23
0.038	53.89	SiO_2 21.79 p. ct	0.038	53.97	SiO_2 21.79 p. ct	0.071	24
0.010	57.00	S 0.006 p. ct.; specific gravity, 4.445. Complete analysis.	0.010	57.00	S 0.006 p. ct	0.018	25
0.415	53.04	Specific gravity, 3.644	0.420	53.74		0.782	26
1.134	47.21	TiO_2 trace	1.146	47.71	TiO_2 trace	2.402	27
1.256	54.71	Specific gravity, 3.744	1.269	55.28		2.296	28
1.537	49.50	Specific gravity, 3.511	1.567	50.46		3.105	29
1.080	53.86	Specific gravity, 3.728	1.091	54.41		2.005	30
0.178	55.54		0.179	55.82		0.320	31
0.570	46.60	Specific gravity, 3.581	0.574	46.91		1.223	32
0.936	55.00		0.943	55.42		1.702	33
0.412	43.89		0.414	44.06		0.939	34
0.156	42.06		0.157	42.37		0.347	35
0.092	35.43	Specific gravity, 3.301	0.092	35.59		0.260	36
0.413	54.90	Specific gravity, 3.778	0.415	55.22		0.752	37
0.604	42.60		0.604	42.60		1.418	38
0.086	57.21		0.086	57.46		0.150	39
0.095	54.12		0.097	55.19		0.176	40
0.044	41.89	Specific gravity, 3.574	0.044	42.25		0.105	41
0.095	51.62		0.095	51.86		0.184	42
1.359	51.41	S 0.258 p. ct.; specific gravity, 3.662. Complete analysis.	1.372	51.98	S 0.260 p. ct	2.636	43
0.191	58.36	Specific gravity, 4.330	0.193	58.88		0.327	44
0.691	55.35	Specific gravity, 3.814	0.705	56.48		1.248	45
0.848	32.17	Specific gravity, 3.201	0.885	32.44		2.636	46
0.156	46.78		0.158	47.38		0.333	47

KENTUCKY.

0.183	50.65		0.186	51.37		0.361	1
0.282	44.51		0.289	45.58		0.634	2
1.094	51.58		1.111	52.37		2.121	3
0.273	34.94		0.280	35.83		0.781	4
0.181	47.51		0.184	48.38		0.381	5
0.528	45.50		0.530	46.35		1.160	6
0.099	49.23		0.100	49.50		0.201	7
0.273	48.03		0.275	48.50		0.568	8
0.120	47.25		0.121	47.62		0.254	9
0.104	48.81		0.105	49.36		0.213	10

TABLE 25.—*Partial analyses of iron ores*—Continued.

KENTUCKY—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
11	King	Chauvenet	From Reuben's Branch; "block ores"	Limonite	593	Pennsylvania furnace, Greenup county
12	do	do	From seam No. 4; "block ore"	Carbonate	594	do
13	do	do	Sample from 10-foot seam of "yellow kidney ore"	do	596	do
14	do	do	"Roll kidney" ore, from 4½-foot level	do	597	do
15	do	do	"Rough and ready" or "China" ore, from 1-foot seam.	Limonite sand	598	do
16	do	do	From 2-inch seams of kidney ore	Carbonate	595	Pea Ridge (Blancet Bros.), Greenup county.
17	do	do	"Little block ore," from 2- to 3-inch seam	Limonite	599	Honeywell furnace, Greenup county
18	do	do	Specimen of one large kidney; not an average sample.	do	600	Turkey Lick, Hunnewell furnace, Greenup county.
19	White	do	From 600 tons at Hunnewell furnace; "block kidney."	Carbonate	801	Hanging Rock, Hunnewell furnace, Greenup county.
20	King	do	From "red lime" ore in bank	do	814	Hunnewell bank, Hunnewell furnace, Lawrence county.
21	do	do	From "gray lime" ore in same bank as No. 814.	do	815	do
22	do	do	From bowlders of kidney ore in same bank as Nos. 814 and 815.	do	816	do
23	White	do	From bank	do	802	S. S. Duzan's Iron Hills furnace, Carter county.
24	do	do	From upper line in kidney vein	do	803	Lambert banks, Iron Hills furnace, Carter county.
25	do	do	From main seam and two small seams above it	do	804	do
26	do	do	From concretionary bowlders in main seam of ore.	Limonite	805	do
27	do	do	From breast of ore in old workings	Carbonate	806	Iron Hills property, Carter county
28	do	do	From kidney ore in bank	Limonite	807	Stewart's bank, Robbin's Run, Carter county.
29	do	do	From "block ore" in same pit as No. 807	Carbonate	808	do
30	do	do	From upper seam of "little block ore"	do	809	Robbin's Run, Mount Savage furnace, Carter county.
31	King	do	From lower seam of "little block ore"	do	810	do
32	do	do	From "gray lime" ore above coal No. 5 (wanting).	do	811	do
33	do	do	From stock pile at Mount Savage furnace, average output of numerous banks in neighborhood.	Carbonate, "kidney," and "block."	812	Mount Savage banks, Mount Savage furnace, Carter county.
34	do	do	From "red kidney" ore in bank	Limonite	813	Bay's Branch, Lost Creek, Carter county.

MAINE.

1	Richmond	Benton	From piles of roasted ore at furnace	Limonite (roasted)	676	Katahdin Iron Works, Piscataquis county.
2	do	do	From pile of raw ore at furnace and from three excavations 1 mile west of furnace.	Limonite	677	do
3	do	do	From pit 1 mile west of furnace	do	678	do

MARYLAND.

1	Richmond	Benton	At Stickney furnace, Baltimore	Carbonate (roasted)	1022	Hanover Switch, Hanover county
2	do	do	do	Carbonate	1023	do
3	do	do	At mine	Carbonate and altered products.	1024	Bowers' Spring Garden, Baltimore, Baltimore county.
4	do	do	From two parallel stringers of nodules of ore at head of drift 40 feet from entrance.	do	1029	Jacob Smith's, near Baltimore, Baltimore county.
5	do	do	From several tons of nodules at mine	do	1030	Mrs. H. Smith's land, Baltimore county.
6	do	do	do	do	1031	Furstenburg, Stemmer's Run station, Baltimore county.
7	do	do	From pile of nodules at mine	do	1032	Reves & Coster, L. Furstenburg's land, Baltimore county.
8	do	do	Selected clippings of white unaltered carbonate ore in pile of 500 tons at Furstenburg's furnace.	do	1033	Furstenburg's furnace, Baltimore county.
9	do	do	Selected clippings of peroxidized ore in same pile.	do	1034	do
10	do	do	Average of same pile	do	1035	do
11	do	do	From 100 tons of roasted ore at Furstenburg's furnace.	Carbonate and altered products (roasted).	1036	do
12	do	do	From 20 tons of nodules at mine	Carbonate and altered products.	1050	Jacob Odensoss' land, near Baltimore, Baltimore county.
13	do	do	From 30 tons of nodules at mine	do	1051	Norris or Whittaker, near Baltimore, Baltimore county.
14	do	do	From the carbonate portion of 3,000 tons of ore at furnace.	do	1052	Stickney Iron Company's furnace, near Baltimore, Baltimore county.
15	do	do	From the peroxidized portion of same pile	do	1053	do
16	do	do	From furnace stock piles; ore from numerous mines in Baltimore county.	do	1054	Maryland or Ellicott's furnace, Baltimore, Baltimore county.
17	do	do	From stock piles of roasted ore from same mines.	Carbonate and altered products (roasted).	1055	do
18	do	do	From 10 tons of lump ore at mine	Limonite	1056	John Ridgeley's land, near Baltimore, Baltimore county.
19	do	do	From 50 tons of washed ore at washer	do	1057	Wood's, near Baltimore, Baltimore county.
20	do	do	From 40 tons of lump ore at mine	do	1058	Miss Talbot's land, near Baltimore, Baltimore county.
21	do	do	From 100 tons of washed ore at washer	do	1059	Kelly, near Baltimore, Baltimore county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

KENTUCKY—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.167	54.39		0.170	55.49		0.306	11
0.227	32.02		0.230	32.50		0.709	12
0.423	32.27		0.428	32.67		1.311	13
0.513	32.01		0.522	32.58		1.603	14
0.139	31.49		0.140	31.78		0.441	15
0.698	54.65		0.710	55.61		1.278	16
0.173	51.10		0.175	51.70		0.339	17
0.099	34.96		0.101	35.60		0.283	18
0.341	36.18		0.345	36.65		0.943	19
0.126	40.61	S 0.218 p. ct. Complete analysis	0.128	40.85	S 0.218 p. ct.	0.313	20
0.141	32.46		0.142	32.65		0.434	21
0.294	39.52		0.298	40.00		0.744	22
0.224	37.32		0.228	37.97		0.600	23
0.260	35.36		0.265	35.98		0.735	24
2.479	34.82		2.565	36.03		7.119	25
0.737	40.48		0.762	41.87		1.821	26
2.510	34.55		2.535	34.90		7.265	27
0.187	31.20		0.189	31.52		0.599	28
0.170	35.63		0.172	36.04		0.477	29
0.215	37.32		0.217	37.67		0.576	30
0.279	34.77		0.282	35.11		0.774	31
0.927	27.73		0.937	28.02		3.343	32
0.223	41.30		0.226	41.84		0.540	33
0.079	22.81		0.080	23.08		0.346	34

MAINE.

0.012	57.20		0.012	57.25		0.021	1
0.009	46.00	S 3.004 p. ct. Complete analysis	0.009	47.88	S 3.127 p. ct	0.019	2
0.037	47.28		0.039	49.66		0.078	3

MARYLAND.

0.112	49.72		0.112	49.72		0.225	1
0.146	43.46		0.148	44.11		0.336	2
0.096	38.54		0.096	38.66		0.249	3
0.092	42.76		0.093	43.24		0.215	4
0.127	46.23		0.129	46.97		0.275	5
0.098	35.75		0.099	35.97		0.274	6
0.094	40.58		0.096	41.27		0.232	7
0.068	36.56		0.068	36.67		0.186	8
0.113	46.17		0.116	47.28		0.245	9
0.089	42.01		0.090	42.69		0.212	10
0.079	47.73		0.080	48.35		0.166	11
0.041	37.53		0.041	37.67		0.109	12
0.149	40.73		0.151	41.31		0.366	13
0.055	37.94		0.055	38.10		0.145	14
0.177	44.41		0.182	45.69		0.399	15
0.073	40.37		0.074	41.41		0.179	16
0.123	45.84		0.124	46.05		0.268	17
0.200	54.42		0.203	55.20		0.368	18
0.102	40.39		0.104	41.01		0.253	19
0.067	52.72		0.068	53.40		0.127	20
0.174	38.96		0.176	39.47		0.447	21

TABLE 25.—*Partial analyses of iron ores*—Continued.

MARYLAND—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
22	Richmond	Benton	From 40 tons of washed ore at washer	Limonite	1060	Oregon, near Ashland furnace, Baltimore county.
23	do	do	From 60 tons of lump ore at mine	do	1061	do
24	do	do	From 150 tons of washed ore at Stevenson's station.	do	1062	Green Spring, near Stevenson's station, Baltimore county.
25	do	do	From car-load of 20 tons at railroad	Carbonate and altered products.	1037	George L. Skagg's land, Branchville station, Prince George's county.
26	do	do	From 10 tons nodules at mine	do	1038	George Yokel's land, near Beltsville station, Prince George's county.
27	do	do	From 1,000 tons of ore at Muirkirk furnace	do	1039	Friel & Millbrook's, Smith's & Wood's mines, Prince George's county.
28	do	do	From piles of roasted ore at furnace	do	1040	do
29	do	do	From 5 tons of ore at furnace	do	1041	Friel & Millbrook's, near Muirkirk furnace, Prince George's county.
30	do	do	Selected clippings of white ore from same pile as No. 1039.	do	1042	do
31	do	do	From 70 tons of ore at mine and near railroad	do	1043	J. O'Brien's land, Contee's station, Prince George's county.
32	do	do	From 50 tons of ore at mine	do	1044	A. S. Linthicum's, near Jessup's station, Anne Arundel county.
33	do	do	From 20 tons of nodules from lowest 6 feet; unaltered carbonate.	do	1045	do
34	do	do	From 25 tons of nodules from dark gray plastic clay forming lower part of exposure.	do	1046	Howard Brown's land, Hanover station, Anne Arundel county.
35	do	do	From 25 tons nodules from light brown siliceous clay in upper part of exposure.	do	1047	do
36	do	do	From 60 tons nodules from dark gray plastic clay (bottom).	do	1048	do
37	do	do	From 40 tons nodules from brown plastic clay (top).	do	1049	do
38	do	do	From 5,000 tons of lump ore at Avondale station.	Limonite	1063	Avondale, Avondale station, Carroll county.
39	do	do	From 70 tons of ore near shaft	Magnetite	1064	Springfield, near Sykesville station, Carroll county.
40	do	do	Across 2-foot vein at bottom of shaft, 100 feet below surface.	do	1065	do
41	do	do	From 2,000 tons fine unwashed ore at mine	Limonite	1066	Ensor, James Scholl's land, Unionville, Frederick county.
42	do	do	From 150 tons lump ore at New Windsor, East station.	do	1067	do
43	do	do	From 25 tons of ore from 150-foot drift and small drifts near it.	do	1068	Catoctin or Kunkel, near Catoctin furnace, Frederick county.
44	do	do	From few tons of washed and screened ore at washer.	do	1069	do
45	do	do	From 50 tons lump ore at mine	do	1070	Grim's, near New Midway station, Frederick county.
46	do	do	From 75 tons screened ore at mine	do	1071	Thomas, near Frederick Junction, Frederick county.
47	do	do	From fragments of ore near mine entrance	do	1075	Bowery, near Borden shaft, Allegany county.
48	do	do	do	Fossil	1076	Frost, near Cumberland, Allegany county.

MASSACHUSETTS.

1	Whitfield	Putnam	Mixed, washed, and rock ore from cars at mine	Limonite	790	Chauncey Leet (Hudson Iron Co.), West Stockbridge, Berkshire county.
2	do	do	From 100 tons washed ore at mine	do	791	Goodrich, West Stockbridge, Berkshire county.
3	do	do	From 30 tons rock ore at mine	do	792	do
4	do	do	From 50 tons washed ore at Richmond furnace	do	793	Nathaniel Leet (Richmond Iron Co.), West Stockbridge, Berkshire county.
5	do	do	From 1,000 tons washed ore at washer	do	794	Cone, Richmond, Berkshire county
6	do	do	From 2,000 tons rock and washed ore at Pomeroy furnace.	do	795	Bank, Richmond, Berkshire county
7	do	do	Rock ore from above pile at Pomeroy furnace	do	796	do
8	do	do	From 300 tons rock and washed ore at Pomeroy furnace.	do	797	Bacon, Richmond, Berkshire county
9	do	do	From 300 tons of rock ore at Pomeroy furnace	do	798	do
10	do	do	From 300 tons washed ore at mine	do	799	Cheever, Richmond, Berkshire county
11	do	do	From 25 tons rock ore at mine	do	800	do

MINNESOTA.

1	King	Willis	From outcrop	Magnetite	977	Sec. 35, T. 54, R. 11 W., Lake county
2	do	do	do	Specular magnetite	978	Sec. 34, T. 56, R. 25 W., Itasca county
3	do	do	do	Specular	979	Sec. 32, T. 62, R. 15 W., Saint Louis county.
4	do	do	do	do	980	Pit 3, Sec. 32, T. 62, R. 15 W., Saint Louis county.
5	do	do	do	do	981	Pit 14, Sec. 28, T. 62, R. 15 W., Saint Louis county.
6	do	do	do	do	982	Pits 4 and 7, Sec. 27, T. 62, R. 15 W., Saint Louis county.
7	do	do	do	do	983	Pit 1, Sec. 27, T. 62, R. 15 W., Saint Louis county.
8	do	do	do	do	984	Pits 11 and 12, Sec. 27, T. 62, R. 15 W., Saint Louis county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

MARYLAND—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.243	41.62		0.249	42.59		0.584	22
0.262	51.90		0.266	52.61		0.505	23
0.482	45.91		0.486	46.36		1.050	24
0.060	40.85		0.061	41.64		0.147	25
0.115	46.51		0.118	47.66		0.247	26
0.073	42.91		0.074	43.60		0.170	27
0.108	46.25		0.108	46.36		0.234	28
0.101	43.25		0.103	44.25		0.233	29
0.060	41.07		0.060	41.32		0.146	30
0.090	45.57		0.093	46.98		0.197	31
0.150	46.79		0.155	48.32		0.321	32
0.066	37.60		0.066	37.80		0.176	33
0.063	37.87		0.063	38.03		0.166	34
0.049	36.17		0.049	36.38		0.135	35
0.025	38.48		0.025	38.68		0.065	36
0.040	36.10		0.040	36.26		0.111	37
0.987	48.50		0.997	48.98		2.035	38
0.243	64.44		0.243	64.47		0.377	39
0.251	64.85		0.251	64.88		0.387	40
0.665	41.41		0.669	41.65		1.606	41
0.817	49.52		0.821	49.77		1.650	42
0.220	40.05		0.225	40.93		0.549	43
0.188	41.55		0.193	42.63		0.452	44
1.363	38.35		1.396	39.27		3.550	45
0.752	30.45		0.760	30.77		2.470	46
0.188	44.68		0.192	45.57		0.421	47
0.217	46.59		0.220	47.38		0.466	48

MASSACHUSETTS.

0.187	47.52		0.189	47.90		0.394	1
0.142	40.71		0.144	41.17		0.349	2
0.124	46.87		0.125	47.36		0.265	3
0.174	46.65		0.175	47.00		0.373	4
0.102	41.80		0.103	42.04		0.244	5
0.248	39.12		0.250	39.41		0.634	6
0.183	50.48		0.184	50.79		0.363	7
0.999	43.17		1.007	43.51		2.314	8
1.249	49.83		1.263	50.38		2.507	9
0.168	45.82		0.169	46.14		0.367	10
0.234	43.82		0.236	44.29		0.534	11

MINNESOTA.

0.027	51.71	Mn. absent; TiO_2 present	0.027	51.73	Mn. absent; TiO_2 present	0.052	1
0.012	50.94	TiO_2 absent	0.012	51.06	TiO_2 absent	0.024	2
0.044	66.46		0.044	66.51		0.066	3
0.044	65.89		0.044	65.96		0.067	4
0.056	68.05		0.056	68.11		0.082	5
0.035	64.55		0.035	64.58		0.054	6
0.059	67.28		0.059	67.30		0.088	7
0.067	65.73		0.067	65.77		0.102	8

TABLE 25.—*Partial analyses of iron ores*—Continued.

MISSOURI.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	King	Chauvenet	From 40 tons at Missouri furnace	Hematite	534	Staunton bank, Sec. 36, T. 41, R. 2 W., Franklin county.
2	White	do	From 300 tons at Staunton, from whole body of pit.	do	581	Staunton bank, Staunton, Franklin county.
3	do	do	From 100 tons on dump	do	579	Saint Clair bank, Sec. 28, T. 42, R. 1 W., Franklin county.
4	do	do	From whole working face of mine	do	580	do
5	King	do	From stock pile at Missouri Furnace Company, Saint Louis.	Specular	535	Cherry valley, Sec. 4, T. 37, R. 3 W., Crawford county
6	do	do	From all parts of bottom of pits No. 1 and 10 feet up side.	Blue specular	550	do
7	do	do	From broken ore and working face	Specular and hematite.	551	do
8	do	do	From working faces of 2 adjoining pits	do	547	Railroad bank, Sec. 14, T. 38, R. 4 W., Crawford county.
9	do	do	From bottom of pit	do	548	Zane bank, Sec. 13, T. 38, R. 4 W., Crawford county.
10	do	do	From a few tons of ore at mine	Hematite	549	Clark bank, Sec. 26, T. 38, R. 4 W., Crawford county.
11	do	do	From greatest depth on dip	do	575	Iron Ridge, Sec. 29, T. 39, R. 5 W., Crawford county.
12	do	do	From face and from bottom of shaft	do	576	Marsh bank, Sec. 5, T. 37, R. 5 W., Crawford county.
13	White	do	From small remnant of ore in pit	Blue specular and hematite.	577	Scotia, Sec. 28, T. 39, R. 2 W., Crawford county.
14	do	do	From 65 tons on dump	Hematite	578	McGarvey bank, near Leasburg, Crawford county.
15	King	do	From stock pile at stockhouse of Missouri Furnace Company, Saint Louis.	Hematite and specular.	536	Missouri furnace, Saint Louis, Saint Louis county.
16	Whitfield	do	From west cut	Specular	537	Shepherd Mountain, Sec. 31, T. 34, R. 4 E., Iron county.
17	White	do	From lower tunnel	do	538	Pilot Knob., Sec. 29, T. 34, R. 4 E., Iron county.
18	do	do	From upper tunnel on driving face	do	539	do
19	do	do	On northeast outcrop above slate seam	do	540	do
20	do	do	From right-hand wall of entrance to cut	do	541	Cedar Hill, Sec. 30, T. 34, R. 4 E., Iron county.
21	King	do	From whole east wall of pit	Hematite "paint ore".	553	Clinton, Sec. 26, T. 36, R. 6 W., Phelps county.
22	do	do	From stock pile from recently opened bank	Hematite	554	Stimson bank, Sec. 10, T. 36 R. 6 W., Phelps county.
23	do	do	From pit 20 feet deep	Blue specular	556	Lamb bank, Sec. 35, T. 36, R. 6 W., Phelps county.
24	do	do	From west working face	Hematite	557	Smith No. 3 (or Brady), Sec. 26, T. 36, R. 6 W., Phelps county.
25	do	do	From stock pile of 10 tons at Maramec furnace	Blue specular and hematite "softpaint".	570	Maramec, Sec. 1, T. 37, R. 6 W., Phelps county.
26	do	do	From face of driving ditch	Hematite	571	Horse Hollow, Sec. 1, T. 35, R. 9 W., Phelps county.
27	do	do	From ore in new pit	Hematite and specular.	572	Ozark, Sec. 3, T. 35, R. 9 W., Phelps county.
28	do	do	From new pit	Hematite	573	Reed bank, Sec. 31, T. 37, R. 6 W., Phelps county.
29	do	do	From stock pile of 200 tons at mine	do	574	Moselle (or Cold Spring), Sec. 26, T. 36, R. 8 W., Phelps county.
30	White	do	From cars; rejected by Vulcan Steel Company.	Specular, with copper.	582	Grand Union, Sec. 31, T. 37, R. 6 W., Phelps county.
31	King	do	From special lot of best No. 1 ore in stock pile	Specular	542	Iron Mountain, Sec. 31, T. 35, R. 4 E., Saint François county.
32	do	do	From 200 tons second-class ore from all parts of third level.	do	543	do
33	do	do	From 40 tons of washed ore at washer	do	544	do
34	do	do	From 100 tons washed ore at washer	do	545	do
35	do	do	From choice pile of No. 1 ore on lowest level of west cut.	do	546	do
36	do	do	From 1,000 tons at Smith's switch	Hematite and specular.	552	Hawkins, Sec. 13, T. 35, R. 6 W., Dent county.
37	do	do	From pile of ore at bank	Hematite	555	Watkins, Sec. 12, T. 35, R. 7 W., Dent county.
38	do	do	Sample from whole output	Hematite, with jasper.	558	Pomeroy, Sec. 10, T. 34, R. 6 W., Dent county.
39	do	do	From whole bottom of pit	Hematite	559	Thomas bank, Sec 20, T. 34, R. 6 W., Dent county.
40	do	do	From 100 tons on cars at dump; ore from southwest side of deepest level.	Hematite and blue specular.	560	Simmons bank, Sec. 24, T. 34, R. 6 W., Dent county.
41	do	do	From all parts of pit	do	561	Milsap & Orchard, Sec. 18, T. 34, R. 5 W., Dent county.
42	White	do	From 20 tons of washed ore at bank	Hematite and specular.	562	Milsap, Sec. 18, T. 34, R. 5 W., Dent county.
43	do	do	From pile at top of shaft 80 feet deep	Specular	563	Nova Scotia, Sec. 26, T. 33, R. 4 W., Dent county.
44	do	do	From No. 8 prospecting shaft	Blue specular	564	do
45	do	do	From 300 tons of ore from main part of pit	do	565	Riverside bank, Sec. 2, T. 33, R. 5 W., Dent county.
46	do	do	From face of ore	Hematite	566	do
47	King	do	do	Specular and soft "paint".	567	Sligo, Sec. 2, T. 35, R. 4 W., Dent county.
48	do	do	do	Hematite and "paint".	568	do
49	do	do	From stock pile at Sligo furnace	Blue specular	569	Fitzwater, Secs. 33 and 34, T. 35, R. 4 W., Dent county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

MISSOURI.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.072	57.85		0.072	58.20		0.124	1
0.058	58.81		0.059	59.34		0.099	2
0.059	62.40		0.060	62.97		0.095	3
0.058	58.86		0.058	59.16		0.099	4
0.082	57.18		0.082	57.48		0.143	5
0.022	65.87	S 0.159 p. ct. Complete analysis	0.022	65.96	S 0.159 p. ct	0.033	6
0.085	58.59		0.086	59.00		0.145	7
0.085	59.41		0.086	59.91		0.143	8
0.080	59.20		0.081	59.74		0.135	9
0.075	55.37		0.076	56.30		0.135	10
0.124	61.36		0.125	61.84		0.202	11
0.058	58.07		0.059	58.71		0.100	12
0.063	63.10		0.063	63.37		0.091	13
0.056	61.42		0.056	61.74		0.115	14
0.065	56.43		0.065	56.78		0.115	15
0.013	65.39	S 0.077 p. ct. Complete analysis	0.013	65.63	S 0.077 p. ct	0.020	16
0.005	59.59	S 0.080 p. ct. Complete analysis	0.005	59.52	S 0.080 p. ct	0.008	17
0.018	52.60	S 0.492 p. ct. Complete analysis	0.018	52.60	S 0.490 p. ct	0.034	18
0.025	50.40		0.025	50.42		0.050	19
0.006	66.61		0.006	66.66		0.009	20
0.048	63.13		0.048	63.29		0.076	21
0.017	54.90		0.017	55.26		0.031	22
0.022	63.38		0.022	63.44		0.035	23
0.026	62.66		0.026	63.04		0.041	24
0.050	63.28		0.050	63.52		0.079	25
0.032	55.73		0.032	56.17		0.057	26
0.042	45.76		0.042	46.20		0.092	27
0.121	54.76	Cu. 2.455 p. ct	0.123	55.86	Cu. 2.455 p. ct	0.221	28
0.074	55.21		0.075	55.94		0.134	29
0.027	31.62	Cu. 21.60 p. ct	0.027	31.67		0.085	30
0.071	66.93		0.071	66.97		0.106	31
0.398	59.06		0.399	59.36		0.674	32
0.032	65.57		0.032	65.71		0.049	33
0.019	64.67		0.019	64.78		0.029	34
0.005	62.84		0.005	62.92		0.008	35
0.040	56.19		0.040	56.79		0.071	36
0.070	59.30	S 0.069 p. ct	0.070	59.98	S 0.070 p. ct	0.118	37
0.079	59.99		0.080	60.62		0.132	38
0.127	57.78		0.128	58.32		0.220	39
0.039	61.97		0.039	62.22		0.063	40
0.067	57.96		0.067	58.29		0.116	41
0.040	60.39		0.040	60.64		0.066	42
0.061	63.77		0.061	64.15		0.096	43
0.025	67.02		0.025	67.10		0.037	44
0.029	63.90	S 0.020 p. ct. Complete analysis	0.029	63.90	S 0.020 p. ct	0.045	45
0.063	64.05	S 0.179 p. ct. Complete analysis	0.063	64.31	S 0.180 p. ct	0.098	46
0.040	65.92		0.040	66.14		0.061	47
0.026	65.03		0.026	65.16		0.040	48
0.035	62.95		0.035	62.95		0.056	49

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEVADA.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	King	Putnam	One lump of ore	Magnetite	1164	Jackson mountains, Humboldt county.

NEW HAMPSHIRE.

1	Richmond	Benton	From stock pile at furnace	Magnetite	679	Franconia furnace, near Littleton, Grafton county.

NEW JERSEY.

1	Blair	Putnam	Across stope, 75 feet east of bottom of shaft	Magnetite	90	Washington, Oxford, Warren county
2	do	do	East of bottom of shaft, 250 feet below surface	do	91	New mine (Carwheel vein), Oxford, Warren county.
3	do	do	100 feet east of shaft, 250 feet below surface	do	92	New mine (Gray vein), Oxford, Warren county.
4	do	do	From 75 tons at Oxford furnace	do	93	Washington, Oxford, Warren county
5	do	do	From 100 tons at Oxford furnace	do	94	Welch, Oxford, Warren county
6	Chauvenet	do	Average of one week's output	do	329	do
7	do	do	do	do	330	New, Oxford, Warren county
8	Blair	do	From 75 tons at Oxford furnace	do	95	New (Gray and Carwheel veins), Oxford, Warren county.
9	do	do	From stock pile of 200 tons at mine	do	96	Kishpaugh, Hope, Warren county
10	do	do	From stock pile of 100 tons at mine	do	97	do
11	do	do	From about 75 tons at mine	do	99	Bald Pate, Mansfield, Warren county
12	do	do	From 100 tons near top of southwest shaft	do	100	Egbert, Mansfield, Warren county
13	do	do	From 25 tons at Stanhope furnace	Limonite	325	Shields, Beattyestown hematite, Mansfield, Warren county.
14	do	do	Across stope in main pit	Magnetite	301	Andover, Andover, Sussex county
15	do	do	From 80 tons of sorted ore on dock	do	302	do
16	do	do	From small vein, or stringers, on side of pit	Hematite (decomposed magnetite?)	303	do
17	do	do	From small opening east of north end of old mine	Magnetite (lodestone).	304	do
18	do	do	From near north end of old mine in old pillar	Specular hematite, black hematite.	305	do
19	do	do	In small pit west of old mine	Mixed hematite and magnetite.	306	do
20	Chauvenet	do	From about 100 tons at kilns	Magnetite (roasted)	347	do
21	Blair	do	From about 1,000 tons at mine	Magnetite	307	Hill, Franklin furnace, Hardyston, Sussex county.
22	do	do	From 150 tons at Franklin furnace	do	308	Pike's Peak, or Furnace vein, Hardyston, Sussex county.
23	do	do	From 75 tons at Franklin furnace	Limonite	309	Pochunk, Franklin furnace, Vernon, Sussex county.
24	Chauvenet	do	From 350 tons at Franklin furnace	Magnetite	310	Canistear, Franklin furnace, Hardyston, Sussex county.
25	Blair	do	From 2,500 tons at mine	do	311	Pardee (Ogden mines), Sparta, Sussex county.
26	Chauvenet	do	From west stope in mine	do	312	Roberts (Ogden mines), Sparta, Sussex county.
27	do	do	From east stope in mine	do	313	do
28	do	do	From 200 tons on railroad dock	do	314	Davenport (Ogden mines), Sparta, Sussex county.
29	do	do	From 50 tons at mine	do	319	Sickles, Sparta, Sussex county
30	do	do	do	do	320	Roseville, Byram, Sussex county
31	do	do	From 25 tons from opening on southwest side of hill.	do	321	Hude, or Stanhope, Byram, Sussex county.
32	do	do	From 500 tons at Stanhope furnace	do	322	do
33	do	do	From drift in mine	do	323	Wright, Byram, Sussex county
34	do	do	From few tons at top of northeast shaft	do	324	do
35	Whitfield	do	From 3 cars of ore at dump	do	395	Cannon (Ringwood mines), Pompton, Passaic county.
36	do	do	From 4 cars of ore at dump	do	396	Peter's (Ringwood mines), Pompton, Passaic county.
37	do	do	From 150 tons at mine	do	397	Hope (new opening), Pompton, Passaic county.
38	do	do	From 100 tons near opening	do	398	Hope (old opening), Pompton, Passaic county.
39	do	do	From 10 cars of ore at dump	Magnetite (partly weathered.)	399	Hewitt, Pompton, Passaic county
40	Chauvenet	do	From stock pile of 6,000 tons at mine	Magnetite	315	Ford mine, Jefferson, Morris county
41	do	do	From 4 cars (about 20 tons), ready for shipment	do	316	Dodge, Jefferson, Morris county
42	do	do	From 300 tons at mine	do	317	Weldon, Jefferson, Morris county
43	Blair	do	From about 110 tons on cars at mine	do	318	Hurd, or Hurdtown, Jefferson, Morris county.
44	Chauvenet	do	From 600 tons at mine	Magnetite ("Blue ore")	320	Mount Olive, Mount Olive, Morris county.
45	do	do	From 75 tons at mine; "red" ore from new shaft.	Magnetite (decomposed).	327	do
46	do	do	From 50 tons at mine; "red ore"	Magnetite	328	Stoutenburgh, Washington, Morris county.
47	do	do	From 400 tons from Wiggins' open cut, southwest hill.	do	336	Hackelbarney, Chester, Morris county
48	do	do	From 336 tons from Jones' cut, southwest hill	do	337	do
49	do	do	From 100 tons, Wiggins' shaft, southwest hill	do	338	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEVADA.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.320	66.75	.....	0.321	66.87	.....	0.479	1

NEW HAMPSHIRE.

0.188	49.01	.....	0.188	49.01	.....	0.384	1

NEW JERSEY.

0.505	57.43	S 0.620 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.383.	0.507	57.60	S 0.622 p. ct.; Mn. present; TiO_2 present	0.879	1
0.151	54.84	S 0.225 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.429.	0.151	54.86	S 0.225 p. ct.; Mn. present; TiO_2 present	0.275	2
0.044	39.54	S 0.758 p. ct.; Mn. present; TiO_2 present; specific gravity, 3.998.	0.044	39.54	S 0.758 p. ct.; Mn. present; TiO_2 present	0.111	3
0.657	61.36	S 0.609 p. ct.; Mn. present; TiO_2 present	0.657	61.38	S 0.609 p. ct.; Mn. present; TiO_2 present	1.070	4
0.077	46.59	S 0.342 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.172.	0.077	46.61	S 0.342 p. ct.; Mn. present; TiO_2 present	0.165	5
0.059	41.60	S 0.585 p. ct.; specific gravity, 3.909	0.059	41.66	S 0.586 p. ct	0.142	6
0.095	46.66	S 0.270 p. ct.; Mn. present; specific gravity, 4.126	0.095	46.66	S 0.270 p. ct.; Mn. present	0.204	7
0.072	43.31	S 0.307 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.084.	0.072	43.37	S 0.307 p. ct.; Mn. present; TiO_2 present	0.166	8
0.036	49.68	S 0.755 p. ct.; Mn. present; TiO_2 present; specific gravity, 3.898.	0.036	50.26	S 0.764 p. ct.; Mn. present; TiO_2 present	0.072	9
0.036	54.71	S 0.542 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.069.	0.036	54.92	S 0.544 p. ct.; Mn. present; TiO_2 present	0.066	10
*0.039	54.10	S 0.025 p. ct	0.039	54.34	S 0.025 p. ct	0.072	11
0.418	47.37	S 4.010 p. ct	0.418	47.41	S 4.013 p. ct	0.882	12
0.257	42.73	S 0.041 p. ct.; specific gravity, 3.494. Complete analysis.	0.258	42.96	S 0.041 p. ct	0.601	13
0.024	42.63	S 2.290 p. ct.; specific gravity, 4.178	0.024	42.66	S 2.291 p. ct	0.056	14
0.022	36.91	S 2.527 p. ct.; specific gravity, 4.086. Complete analysis.	0.022	36.95	S 2.530 p. ct	0.060	15
0.100	32.73	S 0.270 p. ct	0.101	33.22	S 0.274 p. ct	0.306	16
0.001	62.31	S 0.059 p. ct	0.001	62.53	S 0.059 p. ct	0.002	17
0.018	63.62	S 0.057 p. ct	0.018	63.77	S 0.057 p. ct	0.028	18
0.110	41.66	S 0.071 p. ct.; specific gravity, 3.576	0.111	41.80	S 0.072 p. ct	0.265	19
0.020	46.53	S 0.786 p. ct.; specific gravity, 4.187	0.786	46.57	S 0.787 p. ct	0.043	20
0.045	27.88	S 0.267 p. ct.; specific gravity, 3.684	0.045	27.88	S 0.267 p. ct	0.161	21
0.033	33.15	S 0.439 p. ct.; specific gravity, 3.576. Complete analysis.	0.033	33.17	S 0.439 p. ct	0.099	22
0.562	38.60	S 0.132 p. ct.; specific gravity, 3.162	0.575	39.51	S 0.135 p. ct	1.456	23
0.084	35.38	S 0.942 p. ct.; specific gravity, 3.440	0.084	35.44	S 0.944 p. ct	0.237	24
1.067	59.23	S 0.113 p. ct. Complete analysis	1.067	59.23	S 0.113 p. ct	1.801	25
0.613	63.91	S 0.133 p. ct.; specific gravity, 4.674	0.613	63.92	S 0.133 p. ct	0.959	26
0.746	64.22	S 0.105 p. ct.; specific gravity, 4.795	0.746	64.25	S 0.105 p. ct	1.162	27
0.398	47.76	S 0.208 p. ct.; specific gravity, 4.031	0.398	47.78	S 0.208 p. ct	0.833	28
0.050	38.11	S 0.976 p. ct.; specific gravity, 4.361	0.050	38.24	S 0.979 p. ct	0.131	29
0.035	53.92	S 0.013 p. ct.; specific gravity, 3.906	0.035	54.04	S 0.013 p. ct	0.065	30
0.037	49.95	S 0.178 p. ct.; specific gravity, 3.975	0.037	50.36	S 0.179 p. ct	0.074	31
0.057	50.23	S 1.220 p. ct.; specific gravity, 4.048	0.057	50.52	S 1.227 p. ct	0.113	32
0.342	49.88	S 1.382 p. ct	0.345	50.33	S 1.395 p. ct	0.686	33
0.521	47.62	S 2.824 p. ct.; specific gravity, 4.181	0.522	47.74	S 2.831 p. ct	1.094	34
1.567	55.25	Specific gravity, 4.545	1.576	55.57	.....	2.818	35
1.556	55.56	.....	1.560	55.67	.....	2.801	36
0.458	62.66	Specific gravity, 4.802	0.459	62.75	.....	0.731	37
0.448	63.20	Specific gravity, 4.818	0.449	63.33	.....	0.709	38
0.078	52.32	S 3.324 p. ct.; Cr. present; specific gravity, 4.814	0.078	52.68	S 3.347 p. ct	0.149	39
0.313	50.70	S 0.753 p. ct.; specific gravity, 4.152	0.313	50.72	S 0.753 p. ct	0.617	40
0.168	50.70	S 0.443 p. ct.; specific gravity, 4.149	0.168	50.73	S 0.443 p. ct	0.331	41
*0.554	54.80	S 0.266 p. ct.; Mn. present; TiO_2 present; specific gravity, 4.327.	*0.554	54.81	S 0.266 p. ct.; Mn. present; TiO_2 present	1.010	42
0.169	66.02	S 0.096 p. ct. Complete analysis	0.169	66.05	S 0.096 p. ct	0.256	43
0.182	58.92	S 1.960 p. ct.; specific gravity, 4.421	0.183	59.19	S 1.969 p. ct	0.309	44
0.090	63.36	S 0.145 p. ct	0.090	63.39	S 0.145 p. ct	0.142	45
0.639	56.37	S 0.155 p. ct.; specific gravity, 4.298	0.639	56.80	S 0.156 p. ct	1.134	46
0.098	47.21	S 3.290 p. ct	0.098	47.26	S 3.293 p. ct	0.207	47, 48, 49

* Whitfield.

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW JERSEY—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
50	Chauvenet	Putnam	From 75 tons from coal-house vein	Magnetite	339	Hackelbarney, Chester, Morris county.
51	do	do	From 300 tons from Andrew's open cut	do	340	do
52	do	do	From 75 tons from East cut	do	341	do
53	do	do	From 1 car of ore from Tunnel vein	do	342	do
54	do	do	From 400 tons from George vein	do	343	do
55	do	do	From ca. 400 tons at Andrew's shaft, Foley vein	do	344	do
56	do	do	From ca. 20 tons from washer; coal-house vein	Magnetite (decomposed).	345	do
57	do	do	From ca. 27 tons at shaft from washer	do	346	Pitney, Chester, Morris county
58	do	do	From ca. 75 tons at mine	do	348	Taylor's Opening, near Chester Station, Morris county.
59	do	do	From ca. 1,000 tons at mine	Magnetite	349	Samson (or Skellenger), Chester, Morris county.
60	Whitfield	do	From pile of few tons from washer	Magnetite (decomposed).	350	Cooper, Chester, Morris county
61	do	do	From ca. 1,000 tons at mine	Magnetite	351	Styles, Randolph, Morris county
62	do	do	From a few tons at top of shaft No. 1 (southwest shaft).	do	352	Bryant, Randolph, Morris county
63	do	do	From ca. 20 tons at top of shaft No. 2	do	353	do
64	do	do	From ca. 20 tons at top of shaft	do	354	De Hart, Randolph, Morris county
65	do	do	From ca. 10 tons from shaft No. 1	do	355	Lawrence, Randolph, Morris county
66	do	do	From ca. 20 tons from shaft No. 9	do	356	Dalrymple, Randolph, Morris county
67	do	do	From ca. 20 tons from pit No. 5	do	357	do
68	do	do	From cars at McCainsville	do	358	Evers, Randolph, Morris county
69	do	do	do	do	359	Brotherton, Randolph, Morris county
70	do	do	From shaft No. 7; on cars, ready for shipment	do	360	Byram, Randolph, Morris county
71	do	do	From shaft No. 12; on cars, ready for shipment	do	361	do
72	do	do	From shaft No. 6; on cars, ready for shipment	do	362	do
73	do	do	From lumps of ore at top of shaft, and on cars	do	363	do
74	do	do	From ca. 25 tons at top of shaft; from pillar in old mine.	do	364	do
75	do	do	From cars at Dover	do	365	Millon, Randolph, Morris county
76	do	do	From cars at McCainsville	do	366	Randall Hill, Randolph, Morris county
77	do	do	From ca. 25 tons on dock; from sink, pit No. 11	do	367	Dickerson, Randolph, Morris county
78	do	do	From ca. 20 tons on dock; from stope in main chutes, pit No. 2.	do	368	do
79	do	do	From ca 20 tons on dock; from side vein	do	369	do
80	do	do	From cars at McCainsville	do	370	Baker, Randolph, Morris county
81	do	do	From ca. 60 tons on cars at Port Oram	do	371	Stirling, Randolph, Morris county
82	do	do	From ca. 50 tons on cars at mine	Magnetite (partly decomposed).	372	Hurd, Randolph, Morris county
83	do	do	From cars at mine	Magnetite	373	Orchard, Randolph, Morris county
84	do	do	From ca. 50 tons on dock	do	374	Washington forge, Randolph, Morris county.
85	do	do	From ca. 110 tons on cars at mine	do	375	Mount Pleasant, Rockaway, Morris county.
86	do	do	From 4 cars of ore from shaft No. 7	do	376	Richard, Rockaway, Morris county
87	do	do	From 5 cars of ore from shaft No. 6	do	377	do
88	do	do	From 5 cars of ore from shaft No. 3	do	378	do
89	do	do	From 3 cars of ore at mine	do	379	Allen, Rockaway, Morris county
90	do	do	From 12 cars of ore at mine	do	380	Teabo, Rockaway, Morris county
91	do	do	From 80 tons on cars; 24 hours output	do	381	Mount Hope, "Jugular", "Taylor", or "Tunnel vein", Rockaway, Morris county.
92	do	do	From stope, 60 feet below the surface	do	382	Mount Hope, Teabo vein, Rockaway, Morris county.
93	do	do	From 14 cars of ore at Port Oram	do	383	Mount Hope, Cross, or Elizabeth, vein, Rockaway, Morris county.
94	do	do	From 2 cars of ore near mine	Magnetite (weathered)	384	Hickory Hill, Brannin vein, Rockaway, Morris county.
95	do	do	From few tons near shaft	Magnetite	385	Denmark, Rockaway, Morris county
96	do	do	From 2 cars of ore on railroad at Dover	do	386	Beach Glen, Rockaway, Morris county
97	do	do	From drift on top of stope, Scott's tract, 80 feet below tunnel level, northwest vein.	do	387	Glendon, "Hibernia", Rockaway, Morris county.
98	do	do	From drift on top of stope, Scott's tract, 80 feet below tunnel level, southeast vein.	do	388	do
99	do	do	From 24 cars on Hibernia railroad at Rockaway	do	389	do
100	do	do	From 14 cars on Hibernia railroad at Rockaway	do	390	Lower Wood, or Andover, (Hibernia), Rockaway, Morris county.
101	do	do	From canal-boat at Rockaway	do	391	Willis (Hibernia), Rockaway, Morris county.
102	do	do	From ca. 25 tons crushed ore at Splitrock forge	do	392	Cobb, Rockaway, Morris county
103	do	do	From 8 cars at mine; openings 1, 3, 5, and 2	do	393	Green Pond, Rockaway, Morris county
104	do	do	From 30 tons at mine	do	394	Charlotteburg, Rockaway, Morris county.
105	Chauvenet	do	From few tons at top of shaft No. 1	do	331	Turkey Hill, Bethlehem, Hunterdon county.
106	do	do	From few tons at top of shaft No. 3	do	332	do
107	do	do	From few tons at top of shaft No. 4	do	333	do
108	do	do	From few tons at top of shaft, from near surface, much weathered.	Martite (?)	334	Hager, Holland, Hunterdon county
109	do	do	From few tons at top of new shaft	Magnetite	335	High Bridge, Hunterdon county

NEW MEXICO.

1	Whitfield	Putnam	From outcrop	Magnetite	1174	Outcrop near Union Shaft, Cerrillos, Santa Afia county.
2	do	do	Part of the specimens collected by Professor St. John in 1880.	do	1175	Near Elizabethtown, Maxwell land grant, Colfax county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW JERSEY—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.025	56.59	S 3.653 p. ct.	0.025	56.60	S 3.654 p. ct.	0.044	50
0.048	52.06	S 3.763 p. ct.	0.048	52.13	S 3.772 p. ct.	0.092	51, 52
0.075	46.47	S 3.517 p. ct.	0.075	46.55	S 3.523 p. ct.	0.161	53, 54, 55
0.057	48.38	S 0.529 p. ct.; specific gravity, 3.939	0.058	48.88	S 0.534 p. ct.	0.118	56
0.112	50.84	S 0.142 p. ct.	0.112	51.81	S 0.145 p. ct.	0.220	57
*0.086	55.84	S 0.000; specific gravity, 4.112	*0.086	56.00	S 0.000	0.154	58
*0.097	51.39	S 4.158 p. ct.; specific gravity, 4.183	*0.097	51.70	S 4.183 p. ct.	0.188	59
0.156	62.89	TiO_2 present; specific gravity, 4.327	0.158	63.88	TiO_2 present	0.248	60
0.036	37.15	TiO_2 present; specific gravity, 3.610	0.036	37.23	do	0.097	61
0.038	63.24	TiO_2 present; specific gravity, 4.516	0.038	63.30	do	0.060	62
0.025	50.70	TiO_2 present: specific gravity, 4.040	0.025	50.73	do	0.049	63
0.633	50.70	TiO_2 present; specific gravity, 4.095	0.634	50.80	do	1.248	64
0.246	51.62	TiO_2 present; specific gravity, 4.100	0.246	51.70	do	0.477	65
0.366	59.54	TiO_2 present; specific gravity, 4.601	0.366	59.58	do	0.615	66
0.222	55.92	TiO_2 present; specific gravity, 4.315	0.222	55.99	do	0.397	67
0.086	47.89	TiO_2 present; specific gravity, 3.449	0.086	47.98	do	0.180	68
0.214	56.98	TiO_2 present; specific gravity, 4.005	0.215	51.10	do	0.420	69
0.393	38.52	TiO_2 present; specific gravity, 3.784	0.394	38.57	do	1.020	70
0.605	28.24	TiO_2 present; specific gravity, 3.447	0.614	28.67	do	2.142	71
0.790	40.70	Specific gravity, 3.799	0.790	41.00		1.940	72
0.245	59.54	Specific gravity, 4.571	0.245	59.66		0.411	73
2.110	57.75	Specific gravity, 4.537	2.113	57.82		3.653	74
0.583	43.73	Specific gravity, 3.843	0.584	43.84		1.333	75
0.577	44.51	Specific gravity, 4.093	0.578	44.55		1.296	76
1.186	61.62		1.187	61.68		1.924	77
0.282	65.17	Specific gravity, 4.814	0.282	65.23		0.433	78
0.178	63.63		0.178	63.72		0.279	79
0.033	32.02	Specific gravity, 3.469	0.033	32.15		0.103	80
1.342	58.80	Specific gravity, 4.607	1.343	58.84		2.282	81
1.618	57.11	Specific gravity, 4.492	1.620	57.17		2.833	82
1.722	55.00		1.723	55.04		3.130	83
1.261	57.39	Specific gravity, 4.521	1.262	57.45		2.197	84
0.185	64.86	Specific gravity, 4.845	0.185	64.89		0.285	85
0.881	61.43	Specific gravity, 4.703	0.882	61.52		1.434	86
0.851	58.05	Specific gravity, 4.522	0.852	58.14		1.465	87
0.661	62.32	Specific gravity, 4.699	0.661	62.34		1.061	88
0.593	56.99		0.594	57.06		1.041	89
0.468	59.31	Specific gravity, 4.521	0.468	59.35		0.789	90
1.177	58.77	Specific gravity, 3.736	1.178	58.80		2.003	91
0.577	60.61	Specific gravity, 4.590	0.577	60.66		0.952	92
0.971	57.67	Specific gravity, 4.524	0.972	57.73		1.683	93
1.230	60.81	Specific gravity, 4.643	1.230	60.83		2.023	94
0.056	49.76	Specific gravity, 4.313	0.056	49.77		0.113	95
0.025	48.63	Cr. present; specific gravity, 4.021	0.025	48.63	Cr. present	0.051	96
0.407	58.22	Specific gravity, 4.514	0.408	58.34		0.699	97
0.139	57.27	Specific gravity, 4.491	0.139	57.33		0.243	98
0.364	53.78		0.364	53.81		0.677	99
0.223	56.00	Specific gravity, 4.420	0.223	56.03		0.398	100
0.343	49.82	Specific gravity, 4.187	0.343	49.84		0.689	101
0.426	59.79		0.426	59.79		0.712	102
0.033	51.33	Specific gravity, 4.326	0.033	51.37		0.064	103
0.151	58.15	Specific gravity, 4.428	0.151	58.20		0.260	104
0.006	35.31	S 0.126 p. ct.	0.006	35.35	S 0.126 p. ct.	0.017	105
0.000	30.45	S 0.034 p. ct.	0.000	30.51	S 0.034 p. ct.	0.000	106
0.004	52.48	S 0.013 p. ct.	0.004	52.51	S 0.013 p. ct.	0.008	107
0.274	62.71	S 0.093 p. ct.; specific gravity, 4.595	0.276	63.27	S 0.094 p. ct.	0.437	108
0.609	55.15	S 5.172 p. ct.	0.611	55.31	S 5.187 p. ct.	1.104	109

* Whitfield.

NEW MEXICO.

0.008	65.59		0.008	65.78		0.012	1
0.051	56.80		0.051	56.90		0.090	2

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	Whitfield	Putnam	From 400 tons at mine	Magnetite	400	Crawford (Sterling mines), Warwick, Orange county.
2	do	do	From cars	do	701	Red Back (Sterling mines), Monroe, Orange county.
3	do	do	do	do	702	Tiptop (Sterling mines), Warwick, Orange county.
4	do	do	From 50 tons on cars	do	703	Scott (Sterling mines), Monroe, Orange county.
5	do	do	do	do	704	Lake mine (Sterling mines), Warwick, Orange county.
6	do	do	From 250 tons at mine	do	705	Sterling, (Sterling mines), Warwick, Orange county.
7	do	do	Selected pieces of tabular crystalline ore in same pile as No. 705.	do	706	do
8	do	do	From 100 tons at Greenwood furnace	do	707	Hogencamp (Greenwood mines), Monroe, Orange county.
9	do	do	From 75 tons at Greenwood furnace	do	708	Forshee, (Greenwood mines), Monroe, Orange county.
10	do	do	From 100 tons at Greenwood furnace	do	709	Bull (Greenwood mines), Monroe, Orange county.
11	do	do	From 30 tons at Greenwood furnace	do	710	Warwick, Warwick, Orange county
12	do	do	From 2,000 tons at mine	do	711	Forest of Dean, Monroe, Orange county
13	do	do	From 150 tons at West Point furnace	Limonite	728	Cornwall Hematite, Cornwall (?), Orange county.
14	do	do	From selected pieces of "shot" ore, ocher matrix, at mine.	do	712	New Dorp, Staten island, Richmond county.
15	do	do	From 100 tons rock ore at mine	do	713	do
16	do	do	From 3,000 tons washed ore at mine	do	714	do
17	do	do	From 500 tons washed ore at mine	do	715	Tyson's Four Corners, Staten island, Richmond county.
18	do	do	From 100 tons rock ore at mine	do	716	do
19	do	do	From 25 tons "manganese" (earthy) at mine	do	717	do
20	do	do	From 20 tons fine-screened ore at mine	do	718	John Tolles, Staten island, Richmond county.
21	do	do	From 50 tons screened ore at mine	do	719	Cooper & Hewitt's, Staten island, Richmond county.
22	do	do	From selected chippings of hard, dark-colored ore at mine.	do	720	do
23	do	do	From 350 tons at West Point furnace	Magnetite	725	Verplanck Point, Cortland, Westchester county.
24	do	do	From 70 tons at West Point furnace	do	730	Steven's, Long Mountain, Haverstraw, Rockland county.
25	do	do	From 50 tons of washed ore at mine	Limonite	769	Reynolds, Ancram, Columbia county
26	do	do	From 20 tons of mixed washed and rock ore at mine.	do	770	Copake, Copake, Columbia county
27	do	do	From 75 tons of "dead-head"	Carbonate	771	do
28	do	do	From washed ore at Hudson furnace	Limonite	1102	Weed, Ancram (?), Columbia county
29	do	do	From 2,000 tons of spathic ore at Hudson furnace.	Carbonate	1103	Hudson River Spathic Iron Company, Catskill, Columbia county.
30	do	do	From 285 tons No. 1 ore, No. 1 shaft, bottom stope, on dock at Peekskill furnace.	Magnetite	721	Croft, Putnam valley, Putnam county
31	do	do	From 185 tons No. 2 ore, No. 2 shaft, top stope, on dock at Peekskill furnace.	do	722	do
32	do	do	From 400 tons of ore from main shaft on dock at Peekskill furnace.	do	723	Todd, Philipston, Putnam county
33	do	do	From 50 tons of ore from tunnel at mine	do	724	do
34	do	do	From 175 tons of ore at West Point furnace	do	726	Pratt & Sackett, Putnam valley, Putnam county.
35	do	do	From West Point furnace; ore taken out 15 to 20 years ago.	do	727	Rose, Kent, Putnam county
36	do	do	From 100 tons at West Point furnace	do	729	West Point furnace, island in lake Mahopac, Carmel, Putnam county.
37	do	do	From 100 tons at mine	do	731	Stuart, or Sunk, Putnam valley, Putnam county.
38	do	do	From 2,000 tons at new mine	do	732	Lake Mahopac Iron Company, Carmel, Putnam county.
39	do	do	From 1,000 tons, No. 2 ore, at mine	do	733	McCollum (Cheever & Durant's), South East, Putnam county.
40	do	do	From 300 tons, No. 1 ore, at mine	do	734	do
41	do	do	From 25 tons ore from west vein at mine	do	735	do
42	do	do	From 2,500 tons at mine	do	736	Theall (Cheever & Durant's), South East, Putnam county.
43	do	do	From 500 tons at mine	do	737	Brewster (Cheever & Durant's), South East, Putnam county.
44	do	do	From mine, south side room, No. 2, N., 300-foot level, from near foot-wall to point one third the way across the vein.	do	738	Tilly Foster, South East, Putnam county.
45	do	do	From mine, same room as above, middle of the vein.	do	739	do
46	do	do	From same room as above near hanging wall	do	740	do
47	do	do	From mine, 400-foot level, along drift south of shaft.	do	741	do
48	do	do	From mine, room No. 4, S., 300-foot level along roof, contains much chondrodite.	do	742	do
49	do	do	From cars at mine, ore from 110-foot level, Duncan shaft.	do	743	do
50	do	do	From cars at mine, general output 300- (and 400-) foot level.	do	744	do
51	do	do	From cars, selected pieces of variety with green mica.	do	745	do
52	do	do	From cars, selected pieces of apparently nearly pure magnetite.	do	746	do
53	do	do	From drift	Limonite	747	Pawling, Pawling, Duchess county
54	do	do	From car, washed ore	do	748	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
2.004	57.60	S 0.178 p. ct.; Mn. present; TiO_2 present; specific gravity, 3.988.	2.005	57.70	S 0.178 p. ct.; Mn. present; TiO_2 present	3.476	1
0.028	52.93	S 3.603 p. ct	0.028	53.03	S 3.610 p. ct	0.053	2
1.751	54.03	S 0.173 p. ct.; Mn. present; TiO_2 present	1.758	54.24	S 0.174 p. ct.; Mn. present; TiO_2 present	3.241	3
0.711	62.59	S 0.082 p. ct.; Mn. present; TiO_2 present	0.712	62.65	S 0.082 p. ct.; Mn. present; TiO_2 present	1.136	4
1.205	57.25	S 0.088 p. ct.; Mn. present	1.206	57.31	S 0.088 p. ct.; Mn. present	2.105	5
0.284	61.01	S 0.371 p. ct	0.284	61.07	S 0.371 p. ct	0.465	6
0.145	67.75	S 0.365 p. ct	0.145	67.79	S 0.365 p. ct	0.214	7
0.033	52.93	S 2.399 p. ct.; Mn. present	0.033	52.99	S 2.402 p. ct.; Mn. present	0.062	8
0.020	40.33	S 0.453 p. ct.; Mn. present	0.020	40.35	S 0.453 p. ct.; Mn. present	0.050	9
0.390	51.30	S 0.464 p. ct.; Mn. present; TiO_2 present	0.391	51.43	S 0.465 p. ct.; Mn. present; TiO_2 present	0.760	10
0.092	52.35	S 2.748 p. ct	0.092	52.40	S 2.750 p. ct	0.176	11
0.621	63.00	S 0.148 p. ct	0.622	63.07	S 0.148 p. ct	0.984	12
0.240	28.57	Mn. present	0.241	28.73	Mn. present	0.840	13
0.107	29.86	TiO_2 present	0.111	30.90	TiO_2 present	0.358	14
0.043	47.21	Mn. present; TiO_2 present	0.044	47.84	Mn. present; TiO_2 present	0.091	15
0.059	39.72	S 0.391 p. ct. Complete analysis	0.060	40.63	S 0.400 p. ct	0.148	16
0.079	48.74	Mn. present; TiO_2 present	0.081	49.73	Mn. present; TiO_2 present	0.162	17
0.080	41.64	TiO_2 present	0.082	42.82	TiO_2 present	0.192	18
0.050	51.20	Mn. 1.16 p. ct.; Cr_2O_3 present	0.051	51.93	Mn. 1.18 p. ct.; Cr_2O_3 present	0.098	19
0.048	31.81		0.049	32.46		0.151	20
0.022	38.86	Mn. present	0.022	39.41	Mn. present	0.057	21
0.003	51.57	do	0.003	52.36	do	0.006	22
0.072	39.93		0.072	39.99		0.180	23
0.061	44.47	Mn. present	0.061	44.76	Mn. present	0.137	24
0.056	40.61		0.057	40.98		0.138	25
0.424	46.79		0.428	47.23		0.906	26
0.248	30.82		0.249	30.98		0.805	27
0.083	40.21		0.084	40.65		0.206	28
0.159	41.41		0.161	41.88		0.384	29
0.012	59.83		0.012	60.05		0.020	30
0.066	54.08		0.066	54.15		0.122	31
0.033	44.34		0.033	44.38		0.074	32
0.087	47.58		0.087	47.66		0.183	33
0.663	57.23		0.664	57.31		1.158	34
0.064	51.90	Mn. present	0.064	51.98	Mn. present	0.123	35
0.021	44.34	do	0.021	44.50	do	0.047	36
0.359	57.23	TiO_2 present	0.359	57.23	TiO_2 present	0.627	37
0.010	61.87		0.010	61.89		0.016	38
0.255	43.22	TiO_2 present	0.255	43.[illegible]	TiO_2 present	0.590	39
0.247	51.48		0.247	51.56		0.480	40
0.035	59.83	Mn. present	0.035	59.90	Mn. present	0.058	41
0.260	44.24		0.260	44.31		0.588	42
0.074	64.09		0.074	64.18		0.115	43
0.015	48.91	S 0.548 p. ct. Complete analysis	0.015	49.05	S 0.550 p. ct	0.031	44
0.030	49.16		0.030	49.37		0.061	45
0.017	46.28		0.017	46.33		0.037	46
0.016	51.20		0.016	51.24		0.031	47
0.006	48.88		0.006	48.96		0.012	48
0.007	49.66	S 0.538 p. ct. Complete analysis	0.007	49.74	S 0.539 p. ct	0.014	49
0.018	48.14		0.018	48.19		0.037	50
0.039	39.33		0.039	39.56		0.099	51
0.014	60.01		0.014	60.08		0.023	52
0.113	43.22		0.114	43.79		0.201	53
0.137	47.12		0.138	47.50		0.291	54

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
55	Whitfield	Putnam	From 25 tons washed ore at mine	Limonite	749	Valley Pond Iron Company, Pawling, Duchess county.
56	do	do	From 50 tons rock ore at mine	do	750	do
57	do	do	From few tons of washed ore on cars	do	751	Beekmanville, Beekman, Duchess county.
58	do	do	From few tons of rock ore at mine	do	752	do
59	do	do	From 50 tons washed ore on cars	do	753	Sylvan Lake, Beekman, Duchess county.
60	do	do	From 40 tons rock ore at mine	do	754	do
61	do	do	From 70 tons washed and rock ore on cars; principally washed ore.	do	755	Fishkill, East Fishkill, Duchess county.
62	do	do	From 350 tons rock ore at Clove Spring furnace.	do	756	Clove Spring, Unionvale, Duchess county,
63	do	do	From 500 tons washed ore at Clove Spring furnace.	do	757	do
64	do	do	From 150 tons washed ore at mine	do	758	Tower's Spring, Unionvale, Duchess county.
65	do	do	From three cars at station	do	759	Dover Furnace, or White Ore Bed, Dover, Duchess county.
66	do	do	From selected pieces of compact ore at mine	do	760	do
67	do	do	From few tons washed ore at mine	do	761	Amenia, Amenia, Duchess county
68	do	do	From 200 tons washed ore at mine	do	762	Gridley & Sons, Amenia, Duchess county.
69	do	do	From mine. "Dead-head"	Carbonate	763	do
70	do	do	From 34 tons washed ore on cars	Limonite	764	Manhattan, Amenia, Duchess county
71	do	do	From selected pieces of crystallized ore at mine.	do	765	do
72	do	do	From 400 tons of washed ore at mine	do	766	Maltby, North East, Duchess county
73	do	do	From 500 tons of rock ore at mine	do	767	do
74	do	do	From 600 tons of washed ore at mine	do	768	Riga, North East, Duchess county
75	do	do	From a few tons of rock ore at Hudson furnace	do	1101	Dakin, Hudson furnace, North East, Duchess county.
76	Richmond	do	From 1,500 tons of ore at mine	Magnetite	1177	Potter mine, Fort Ann, Washington county.
77	do	do	From 1,000 tons of ore near west end of tunnel	do	1178	Mount Hope mine, Fort Ann, Washington county.
78	do	do	From 2,500 tons of ore from north pit	do	1179	Lee mine, Moriah, Essex county
79	do	do	From 1,500 tons of ore from south pit	do	1180	do
80	do	do	Across south end of breast	do	1181	Cheever ore bed, Moriah, Essex county.
81	do	do	Middle of breast from foot-wall to rock midway between walls.	do	1182	do
82	do	do	Middle of breast from rock to hanging-wall	do	1183	do
83	do	do	Across north end of breast	do	1184	do
84	do	do	Selected chippings from 100 tons of lump ore on dock.	Magnetite (lump ore)	1185	do
85	do	do	From 500 tons at Bay State Iron Company's furnace.	Magnetite (fine ore)	1186	do
86	do	do	From 30,000 tons at Port Henry	Magnetite (lump ore)	1187	Mine No. 21, Moriah, Essex county
87	do	do	From 40,000 tons at Port Henry	Magnetite (fine ore)	1188	do
88	do	do	From 16,000 tons at Port Henry	Magnetite (surface ore)	1189	do
89	do	do	From 8,500 tons at Port Henry	Magnetite	1190	Fisher Hill, Moriah, Essex county
90	do	do	From 23,000 tons at Port Henry	Magnetite (lump ore)	1191	Old Bed, Moriah, Essex county
91	do	do	From 38,000 tons at Port Henry	Magnetite (fine ore)	1192	do
92	do	do	From 5,000 tons at Port Henry	Magnetite	1193	New Bed, Moriah, Essex county
93	do	do	From 200 tons at Port Henry	Magnetite (lump ore)	1194	Cook's shaft (Smith mine), Moriah, Essex county.
94	do	do	From 3,000 tons at Port Henry	Magnetite (fine ore)	1195	do
95	do	do	From 500 tons of ore at Bay State Iron Company's furnace.	Magnetite	1196	Barton Hill, Moriah, Essex county
96	do	do	From 30 tons primitive ore at Putnam's forge, near Russia.	do	1197	Gates mine, Elizabethtown, Essex county.
97	do	do	From 15 tons separated at Putnam's forge	Magnetite (separated ore).	1198	do
98	do	do	From 50 tons of primitive ore near separator	Magnetite	1199	Hale mine, Keen, Essex county
99	do	do	From 100 tons separated ore at separator	Magnetite (separated ore).	1200	do
100	do	do	From separated ore at forges	do	1347	Hammondville, or Crown Point, Crown Point, Essex county.
101	do	do	From 7,000 tons of ore at pit No. 8	Magnetite	1348	do
102	do	do	From 3,000 tons of ore at Crown Point	do	1349	do
103	do	do	From 30 tons of ore from pit No. 8 at Crown Point furnace.	do	1350	do
104	do	do	From broken ore in stope, Welch shaft	do	1351	Welsh shaft, Port Henry Iron Company, Moriah, Essex county.
105	do	do	From broken ore in stope	Magnetite (compact ore).	1352	Mine No. 21, Port Henry Iron Company, Moriah, Essex county.
106	do	do	From cars at mine	Magnetite	1353	Noland's shaft, Port Henry Iron Company, Moriah, Essex county.
107	do	do	do	do	1354	Miller pit, Witherbee, Sherman & Co., Moriah, Essex county.
108	do	do	do	do	1355	Pott's shaft, Witherbee, Sherman & Co., Moriah, Essex county.
109	do	do	do	do	1356	Old Bed, Witherbee, Sherman & Co., Moriah, Essex county.
110	do	do	do	do	1357	Teft shaft, Witherbee, Sherman & Co., Moriah, Essex county.
111	do	do	do	do	1358	Barton Hill (south side), Moriah, Essex county.
112	do	do	From 75 tons at top of shaft	do	1359	New Teft, east shaft, Moriah, Essex county.
113	do	do	From 6,000 tons of ore at separator	do	1301	Palmer Hill, Black Brook, Clinton county.
114	do	do	From 7,500 tons of separated ore at separator	do	1302	do
115	do	do	From 500 tons of primitive ore at separator	do	1303	Palmer Hill, Pennsylvania Steel and Iron Co.'s pit, Black Brook, Clinton county.
116	do	do	From 1,000 tons of separated ore at separator	do	1304	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.165	48.93		0.167	49.39		0.337	55
0.158	48.70		0.160	49.37		0.324	56
0.069	29.50	Mn. present	0.070	29.74	Mn. present	0.234	57
0.050	51.85	do	0.051	52.39	do	0.096	58
0.050	48.48	do	0.050	48.81	do	0.103	59
0.041	47.05	do	0.041	47.32	do	0.087	60
0.073	40.92	S 0.143 p. ct. Complete analysis	0.074	41.29	S 0.144 p. ct	0.179	61
0.083	48.74		0.084	49.21		0.170	62
0.128	45.22		0.129	45.68		0.283	63
0.049	34.18		0.050	34.57		0.143	64
0.203	37.75		0.205	38.12		0.538	65
0.743	52.50		0.752	53.14		1.415	66
0.092	46.28		0.092	46.50		0.190	67
0.413	48.99	S 0.152 p. ct. Complete analysis	0.415	49.25	S 0.153 p. ct	0.843	68
0.058	42.94		0.053	43.15		0.123	69
0.086	47.77		0.087	48.08		0.180	70
0.038	50.13	Mn. 1.49 p. ct	0.038	50.48	Mn. 1.50 p. ct	0.076	71
0.156	41.00		0.157	41.36		0.380	72
0.215	48.05		0.217	48.39		0.447	73
0.611	41.58		0.621	42.26		1.470	74
0.357	40.35		0.358	40.51		0.885	75
0.000	61.82	TiO_2 absent	0.000	62.03	TiO_2 absent	0.000	76
0.055	36.99	do	0.055	37.03	do	0.149	77
0.047	45.01	do	0.047	45.05	do	0.104	78
0.034	44.38	do	0.034	44.42	do	0.077	79
0.643	65.33	TiO_2 present	0.644	65.47	TiO_2 present	0.984	80
0.603	63.50	TiO_2 absent	0.604	63.56	TiO_2 absent	0.950	81
0.689	63.86	TiO_2 present	0.690	63.94	TiO_2 present	1.079	82
0.452	64.42	do	0.452	64.48	do	0.702	83
0.673	64.77	do	0.674	64.82	do	1.039	84
0.573	63.08	do	0.574	63.16	do	0.908	85
1.496	61.39	do	1.496	61.39	do	2.437	86
1.118	62.66	do	1.119	62.70	do	1.784	87
1.198	62.10	do	1.200	62.20	do	1.928	88
0.030	46.91	do	0.030	46.96	do	0.064	89
1.129	61.46	do	1.130	61.52	do	1.837	90
0.967	63.01	do	0.968	63.08	do	1.535	91
0.002	43.74	TiO_2 absent	0.002	43.76	TiO_2 absent	0.005	92
0.946	62.66	TiO_2 present	0.947	62.74	TiO_2 present	1.510	93
0.870	62.80	do	0.871	62.90	do	1.385	94
0.048	49.86	do	0.048	49.94	do	0.096	95
0.456	43.21	do	0.457	43.29	do	1.055	96
0.136	64.14	do	0.136	64.21	do	0.212	97
0.000	49.37	TiO_2 absent	0.000	49.49	TiO_2 absent	0.000	98
0.002	59.92	do	0.002	60.00	do	0.003	99
0.030	63.30	TiO_2 present	0.030	63.36	TiO_2 present	0.047	100
0.090	50.73	do	0.090	50.79	do	0.177	101
0.029	49.09	do	0.029	49.20	do	0.059	102
0.107	52.25	do	0.107	52.33	do	0.200	103
1.266	57.71	do	1.268	57.78	do	2.194	104
0.465	67.38	do	0.466	67.46	do	0.069	105
1.282	61.39	do	1.283	61.42	do	2.088	106
0.830	60.54	do	0.830	60.57	do	1.371	107
1.302	61.53	do	1.303	61.58	do	2.116	108
0.908	62.64	do	0.909	62.68	do	1.449	109
0.876	61.92	do	0.877	61.96	do	1.253	110
0.019	39.15	do	0.019	39.17	do	0.049	111
0.019	52.58	do	0.019	52.61	do	0.036	112
0.023	44.94		0.023	44.96		0.053	113
0.007	66.03		0.007	66.06		0.010	114
0.000	33.52		0.000	33.73		0.000	115
0.002	63.45		0.002	63.48		0.003	116

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
117	Richmond	Putnam	From 400 tons of primitive ore at new separator.	Magnetite	1313	Bowen and Signors, Black Brook, Clinton county.
118	do	do	From 100 tons of separated ore at old separator.	do	1314	do
119	do	do	From a few tons of crushed ore at separator	do	1315	Tremblay's, Black Brook, Clinton county.
120	do	do	From a few tons of separated ore at separator	do	1316	do
121	do	do	From stope, second level, 300 feet north of shaft, "gray vein."	do	1305	Arnold, Ausable, Clinton county
122	do	do	From third level, about 200 feet north of shaft, "gray vein."	Martite (?)	1306	do
123	do	do	From end of drift, second level, 400 feet south of shaft, "black vein."	do	1307	do
124	do	do	Chippings from large lumps from pile of 4,000 tons of shipping or "chunk" ore, "old blue vein."	Magnetite	1310	do
125	do	do	From fine ore in pile of ca. 4,000 tons of "chunk" (shipping) ore.	do	1311	do
126	do	do	From ca. 2,000 tons of separated ore at Perona station.	do	1312	do
127	do	do	From 300 tons of separated ore at separator	do	1308	Nelson Bush (New Arnold), Ausable, Clinton county.
128	do	do	From ca. 1,500 tons of ore at station	do	1309	do
129	do	do	From 22 cars of furnace ore ready for shipment.	do	1317	Chateaugay, Dannemora, Clinton county.
130	do	do	From 100 tons separated ore at No. 2 separator	do	1318	do
131	do	do	From 150 tons separated ore at No. 3 separator	do	1319	do
132	do	do	From 150 tons separated ore at separator	do	1320	"81," Dannemora, Clinton county
133	do	do	From 300 tons of ore at separator	do	1321	do
134	do	do	From 2,300 tons of ore at Franklin furnace	Fossil	1322	Franklin Iron Company, Kirkland, Oneida county.
135	do	do	From 30 tons of ore at mine	do	1328	Norton's, Kirkland, Oneida county
136	do	do	From ore at mine	do	1329	Butler ore bed, Kirkland, Oneida county.
137	do	do	From 400 tons of ore at mine	do	1330	Well's ore bed, Kirkland, Oneida county.
138	do	do	From a few tons of ore at mine	do	1323	Davis', New Hartford, Oneida county
139	do	do	From 40 tons of ore at Kirkland furnace	do	1324	Pryers' ore bed, Westmoreland, Oneida county.
140	do	do	From 100 tons of ore at mine	do	1325	Derwin's farm, Westmoreland, Oneida county.
141	do	do	do	do	1326	Caglin's farm, Onondago Iron Co., Verona, Oneida county.
142	do	do	From a few tons of ore at mine	do	1327	John Klein's, Verona, Oneida county
143	do	do	From 150 tons of ore at mine	do	1331	La Frois' ore bed, Ontario, Wayne county.
144	do	do	From a few tons of ore at mine	do	1332	Hurley's ore bed, Ontario, Wayne county.
145	do	do	do	do	1333	Ontario Iron Co. (East bed), Ontario, Wayne county.
146	do	do	From 30 tons of ore at mine	do	1334	Bundy's ore bed, Ontario, Wayne county.
147	do	do	From 3 car-loads of ore at mine	Hematite	1341	Keene, Antwerp, Jefferson county
148	do	do	From cars at station	do	1342	Dickson, Antwerp, Jefferson county
149	do	do	do	do	1343	Old Stirling, Antwerp, Jefferson county.
150	do	do	From 25 tons sorted ore at mine	do	1344	Shurtliff, Philadelphia, Jefferson county.
151	do	do	From a few tons of sorted ore at mine	do	1336	Little Kearny, or New Kearny, Gouverneur, Saint Lawrence county.
152	do	do	From 4,000 tons of ore at mine	do	1337	Karney, Gouverneur, Saint Lawrence county.
153	do	do	From pillar in Dillman's pit, about 100 feet below surface.	do	1338	Caledonia, Rossie, Saint Lawrence county.
154	do	do	From cars at mine, ore from Fox pit and end of cross-drift at bottom of west slides.	do	1339	do
155	do	do	From cars at mine, ore from Shatreau's pit	do	1340	do
156	do	do	From 500 tons of ore at Alpine furnace	Magnetite	1345	Jay ore bed, Fine, Saint Lawrence county.

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1	Pitman	Willis	Specimens of ore from test pit	Specular	151	Lobdel's, near Gaston, Halifax county.
2	do	do	Surface ore from ledge exposed in old pit	Limonite	152	Old Frost mine, Wilson's Mills, Johnson county.
3	do	do	From concretions thrown from two small pits	do	153	D. T. Boney's, near Teachey's, Duplin county.
4	do	do	From ore near old pit	do	154	Bloomary, near Wilson's, Nash county.
5	do	do	From blocks of lean ore in old pits	Specular	155	Buckhorn, Cape Fear river, Harnett county.
6	do	do	From 200 pounds thrown out in opening coal mine, "Ball ore."	Carbonate	156	J. L. Horton's coal mine, The Gulf, Chatham county.
7	do	do	From bed 20 feet below surface, "Blackband"	do	161	do
8	do	do	From 5 tons of ore near the openings	Specular	157	Evan's coal mine, near The Gulf, Chatham county.
9	do	do	From bed in shaft 16 feet deep	Limonite	162	Opening 50 feet south of Stinson road, ½ mile west of The Gulf, Chatham county.
10	do	do	From 1½ tons of ore near shaft 90 feet deep	do	158	Opening No. 11, 90-foot shaft, Ore Hill, Chatham county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

NEW YORK—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe_2	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.124	34.28	TiO_2 absent	0.124	34.33	TiO_2 absent	0.362	117
0.037	66.78	do	0.037	66.81	do	0.055	118
0.017	28.62	do	0.017	28.63	do	0.059	119
0.004	65.01	TiO_2 present	0.004	65.04	TiO_2 present	0.006	120
0.079	59.92	TiO_2 absent	0.079	59.94	TiO_2 absent	0.131	121
0.113	61.28	do	0.113	61.28	do	0.184	122
0.012	62.84	do	0.012	62.84	do	0.019	123
0.114	62.05	do	0.114	62.06	do	0.184	124
0.191	60.87	TiO_2 present	0.191	60.89	TiO_2 present	0.314	125
0.107	63.96	do	0.107	63.97	do	0.167	126
0.102	61.62	TiO_2 trace	0.102	61.63	TiO_2 trace	0.165	127
0.344	54.60	TiO_2 present	0.344	54.63	TiO_2 present	0.630	128
0.011	45.21	TiO_2 absent	0.011	45.26	TiO_2 absent	0.024	129
0.003	66.00	TiO_2 present	0.003	66.07	TiO_2 present	0.005	130
0.103	62.78	do	0.103	62.82	do	0.164	131
0.017	65.14	do	0.017	65.19	do	0.026	132
0.041	34.81	TiO_2 absent	0.041	34.85	TiO_2 absent	0.118	133
0.710	44.22	do	0.712	44.32	do	1.606	134
0.665	39.88	do	0.668	40.06	do	1.668	135
0.554	45.73	do	0.555	45.81	do	1.211	136
0.640	46.79	do	0.641	46.86	do	1.368	137
1.116	43.76	do	1.119	43.87	do	2.550	138
0.753	42.90	do	0.758	43.16	do	1.755	139
0.693	40.40	do	0.705	41.10	do	1.715	140
0.328	40.27	do	0.332	40.89	do	0.815	141
0.248	21.85	do	0.249	21.95	do	1.135	142
0.481	42.25	do	0.482	42.35	do	1.138	143
0.531	40.73	do	0.532	40.83	do	1.304	144
0.578	41.46	do	0.580	41.60	do	1.394	145
0.471	38.36	do	0.472	38.46	do	1.254	146
1.138	42.18	do	1.139	42.18	do	2.698	147
0.285	46.32	do	0.285	46.38	do	0.615	148
0.130	41.92	do	0.130	42.04	do	0.310	149
0.204	40.40	do	0.206	40.87	do	0.500	150
0.226	44.35	do	0.228	44.75	do	0.509	151
0.214	46.46	do	0.215	46.65	do	0.461	152
0.115	48.36	do	0.115	48.43	do	0.238	153
0.212	36.78	do	0.212	36.85	do	0.576	154
0.156	54.16	do	0.156	54.28	do	0.288	155
0.009	56.72	do	0.009	56.75	do	0.016	156

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0.005	49.83		0.005	49.84		0.010	1
0.900	47.99		0.900	48.21		1.875	2
1.085	46.70		1.093	47.04		2.323	3
0.049	49.90		0.050	50.61		0.098	4
0.016	37.31		0.016	37.34		0.043	5
0.312	34.96	Specific gravity, 3.448	0.313	35.10		0.892	6
0.017	21.25		0.017	21.38		0.080	7
0.018	25.75	TiO_2 present; specific gravity, 3.273	0.018	25.78	TiO_2 present	0.070	8
0.068	20.33		0.068	20.72		0.334	9
0.390	57.23	S 0.263 p. ct. Complete analysis	0.400	58.76	S 0.270 p. ct.	0.661	10

TABLE 25.—*Partial analyses of iron ores*—Continued.

NORTH CAROLINA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
11	Pitman	Willis	From face of very compact vein	Limonite	159	Opening No. 10, Ore Hill, Chatham county.
12	do	do	From face of ore in old tunnel	Hematite	160	Opening No. 4, Ore Hill, Chatham county.
13	do	do	From bottom of shaft No. 1	do	164	Smith, Lockville, Chatham county
14	do	do	From bed exposed in 3 pits	do	163	"Cole" mine, near Sandford, Moore county.
15	do	do	From 5 tons of ore from drift 70 feet below surface.	Magnetite	165	Dannemora, near Brown's Summit, Rockingham county.
16	do	do	Fine ore (screenings) from same shaft	do	166	do
17	do	do	From fragments near the Sargent shaft	do	167	Sargent's shaft, Tuscarora iron works, Guilford county.
18	do	do	From fragments near old pits	Limonite	404	Propst's openings, near Hickory, Burke county.
19	do	do	From a few fragments of ore near old pit	Magnetite	168	Hard Ore bank, near Danbury, Stokes county.
20	do	do	From tunnel No. 1, 15 feet below surface	Magnetite (disseminated).	169	Pepper bank, near Danbury, Stokes county.
21	do	do	From 2 tons of ore near old pit	Magnetite	170	Roger's bank, near Danbury, Stokes county.
22	do	do	From bed of ore exposed in trench	do	179	Nelson's bank, near Danbury, Stokes county.
23	do	do	From surface fragments north of trench	do	180	do
24	do	do	From surface fragments near very old trenches	Limonite	181	Outcrop near Danbury, Stokes county.
25	do	do	From upper vein of ore just above water-level	Magnetite	171	Ferris or Hinchum bank, Hyatt's forge, Surry county.
26	do	do	From lower vein of ore at water-level	do	172	do
27	do	do	Stamped and washed ore	do	173	do
28	do	do	From specimens mined 100 feet from shaft	do	174	do
29	do	do	From numerous small shafts	do	175	Hyatt's bank, Bull Run creek, Surry county.
30	do	do	Stamped and washed ore	do	176	do
31	do	do	From 3-inch vein (lead)	do	177	Williams bank, near Rockford, Surry county.
32	do	do	From pile of ore at mine	do	178	Poplar Branch bank, Rockford, Surry county.
33	do	do	From 4 tons of ore near shaft	do	182	Killian, near Lincolnton, Lincoln county.
34	do	do	From 3-foot vein at depth of 20 feet	do	183	Forney bank, near Lincolnton, Lincoln county.
35	do	do	From ore mined in shaft near water-level	Magnetite and hematite.	184	Big bank, near Lincolnton, Lincoln county.
36	do	do	From old pile of ore near pump-shaft	Magnetite	185	Costner bank, near King's mountain, Gaston county.
37	do	do	From 500 pounds of "flint" thrown aside as worthless.	do	186	do
38	do	do	From numerous lumps near old pits	do	187	Ellison bank, near King's mountain, Gaston county.
39	do	do	From 15 tons of ore near cut	Limonite	188	Mine Mountain, near King's mountain, Gaston county.
40	do	do	From 5 tons of ore near opening	do	189	do
41	do	do	From 2 tons of ore from shaft	do	190	Ormond bank, near King's mountain, Gaston county.
42	do	do	From 20 tons of "gray ore"	Magnetite	191	Yellow Ridge, south end, near King's mountain, Gaston county.
43	do	do	From fragments of ore from western side of vein.	do	192	do
44	do	do	From fragments of ore near test pit and whim shaft.	do	193	Yellow Ridge, north end, King's mountain, Gaston county.
45	do	do	From outcrop of vein 2½ feet thick	Magnetite and hematite.	194	Opening, Crowder's mountain, Gaston county.
46	do	do	From 1 ton of ore near old trench	Limonite	195	do
47	do	do	From 10-foot vein in main shaft	Specular	402	Chapel Hill, Chapel Hill, Orange county
48	do	do	From extreme northern shaft	do	403	do
49	do	do	From outcrop in bluff	Magnetite	405	Curtis, Yadkin river, near Patterson, Caldwell county.
50	do	do	From outcrop of thin veins in slate	Specular	406	Ramsours, near head of Dennis creek, Watauga county.
51	do	do	Pure magnetite from near southern end of workings.	Magnetite	407	Cranberry, Big Yellow mountain, Mitchell county.
52	do	do	Magnetite with pyroxene from same opening	do	408	do
53	do	do	Magnetite with epidote from opening 100 yards northeast of the above.	do	409	do
54	do	do	Coarsely crystalline pyroxene from same opening as Nos. 407 and 408.	do	410	do
55	do	do	From small pile of ore at mine	do	411	Wilder's, Iron mountain, Greasy creek, Mitchell county.
56	do	do	Across stope in cut	do	412	Big Ivy bank, Big Ivy creek, Madison county.
57	do	do	do	Limonite	413	Morse's property, Valley River valley, Cherokee county.
58	do	do	From stope; "hard ore"	do	414	Tomotla, 1st range, Valley River valley, Cherokee county.
59	do	do	From near top of vein in one of the openings	do	415	"Section 6", 1st range, Valley River valley, Cherokee county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

NORTH CAROLINA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.232	41.71		0.235	42.29		0.556	11
0.248	44.99	Specific gravity, 3.607	0.252	45.70		0.551	12
0.593	43.02	TiO_2 present; specific gravity, 3.776	0.601	43.56	TiO_2 present	1.380	13
0.313	48.67		0.318	49.52		0.643	14
0.023	48.31	S 0.089 p. ct.; specific gravity, 4.453. Complete analysis.	0.023	48.41	S 0.089 p. ct	0.048	15
0.001	46.89	Mn. trace; TiO_2 present; specific gravity, 3.829	0.001	49.41	Mn. trace; TiO_2 present	0.002	16
0.005	53.20	Mn. trace; TiO_2 present; specific gravity, 4.667	0.005	53.20	Mn. trace; TiO_2 present	0.009	17
1.357	54.84		1.385	55.98		2.474	18
0.000	56.04	Specific gravity, 4.359	0.000	56.04		0.000	19
0.033	43.92	Specific gravity, 3.774	0.033	44.08		0.075	20
0.001	58.26	S 0.179 p. ct.; specific gravity, 4.519. Complete analysis.	0.001	58.30	S 0.179 p. ct	0.002	21
0.040	39.70	Specific gravity, 3.443	0.040	39.87		0.101	22
0.015	44.45	Mn. present; specific gravity, 3.907	0.015	44.64	Mn. present	0.034	23
0.690	47.76	TiO_2 present; specific gravity, 3.577	0.701	48.50	TiO_2 present	1.442	24
0.094	48.02	S 0.106 p. ct.; Mn. present; specific gravity, 3.842	0.095	48.46	S 0.107 p. ct.; Mn. present	0.196	25
0.073	60.41	S 0.112 p. ct.; Mn. trace; specific gravity, 4.323	0.074	61.02	S 0.113 p. ct.; Mn. trace	0.121	26
0.056	67.10	S 0.133 p. ct.; Mn. present; specific gravity, 4.865	0.056	67.30	S 0.133 p. ct.; Mn. present	0.083	27
0.051	60.16	S 1.956 p. ct.; Mn. trace; specific gravity, 4.305	0.051	60.73	S 1.975 p. ct.; Mn. trace	0.085	28
0.049	38.76	Specific gravity, 3.713	0.049	38.80		0.126	29
0.033	63.30	Specific gravity, 4.718	0.033	63.34		0.052	30
0.022	45.28	Specific gravity, 3.901	0.022	45.47		0.049	31
0.029	56.08	Specific gravity, 4.336	0.029	56.21		0.052	32
0.036	64.92	Specific gravity, 4.695	0.036	65.25		0.055	33
0.009	64.96	TiO_2 present; specific gravity, 4.745	0.009	65.16	TiO_2 present	0.014	34
0.013	58.38	S 0.086 p. ct.; specific gravity, 4.495. Complete analysis.	0.013	58.56	S 0.086 p. ct	0.022	35
0.002	51.75	Specific gravity, 4.179	0.002	52.00		0.004	36
0.004	44.82	Specific gravity, 3.935	0.004	44.90		0.009	37
0.016	54.61	Specific gravity, 4.440	0.016	54.71		0.029	38
0.009	61.00	S 0.090 p. ct.; specific gravity, 4.180. Complete analysis.	0.009	61.20	S 0.090 p. ct	0.015	39
0.005	58.37	S 0.112 p. ct.; specific gravity, 4.391. Complete analysis.	0.005	58.73	S 0.113 p. ct	0.009	40
0.092	65.82	Mn. present; specific gravity, 4.748	0.092	66.03	Mn. present	0.140	41
0.009	57.64	S 0.441 p. ct.; specific gravity, 4.388	0.009	57.80	S 0.441 p. ct	0.016	42
0.010	57.43	S 0.101 p. ct.; specific gravity, 4.311	0.010	57.49	S 0.101 p. ct	0.017	43
0.030	59.24	Specific gravity, 4.434	0.030	59.35		0.051	44
0.020	50.39	TiO_2 present; specific gravity, 4.396	0.020	50.50	TiO_2 present	0.040	45
0.604	55.17	Specific gravity, 3.790	0.621	50.72		1.095	46
0.057	37.91	S 0.153 p. ct.; specific gravity, 3.551. Complete analysis.	0.057	37.94	S 0.153 p. ct	0.150	47
0.170	42.64	TiO_2 present; specific gravity, 3.719	0.170	42.69	TiO_2 present	0.399	48
0.076	25.73	TiO_2 38.81 p. ct	0.076	25.76	TiO_2 38.81 p. ct	0.295	49
0.012	44.45		0.012	44.45		0.027	50
0.004	64.64	S 0.115 p. ct.; specific gravity, 4.753. Complete analysis.	0.004	64.87	S 0.115 p. ct	0.006	51
0.007	44.08	S 0.128 p. ct	0.007	44.29	S 0.129 p. ct	0.016	52
0.010	32.37	S 0.128 p. ct.; specific gravity, 3.637. Complete analysis.	0.010	32.49	S 0.128 p. ct	0.031	53
0.009	24.01	Specific gravity, 3.353	0.009	24.53		0.037	54
0.012	63.36	Specific gravity, 4.964	0.012	63.41		0.019	55
0.005	42.95		0.005	42.97		0.012	56
0.021	57.84	Specific gravity, 3.806	0.021	58.42		0.036	57
0.291	55.85	Specific gravity, 3.779	0.294	56.42		0.521	58
0.387	58.25	S 0.160 p. ct	0.391	58.80	S 0.161 p. ct	0.664	59

TABLE 25.—*Partial analyses of iron ores*—Continued.

NORTH CAROLINA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
60	Pitman	Willis	From portion of vein in old cut	Limonite	416	Montieth's, 3d range, near Murphy, Cherokee county.
61	do	do	From a few pieces by side of old pit	do	417	Little's, 2d range, near Murphy, Cherokee county.
62	do	do	From small pile of ore from new pit	Magnetite	941	Hampton's bank, Horse creek, Ashe county.
63	do	do	From surface fragments near old pits	do	942	"Joe Graybeals", Horse creek, Ashe county.
64	do	do	From upper part of vein	do	943	Poison Branch bank, Helton creek, Ashe county.
65	do	do	From lower part of vein	do	944	do
66	do	do	Across stope	do	945	N. B. Barlow's bank, Helton creek, Ashe county.
67	do	do	From outcrop; "gossan"	Limonite	946	Johnson's ridge of Elk Knob, Ashe county.

OHIO.

1	King	Willis	From stock pile at Monitor furnace	"Red kidney" (C. M.)	1208	Lawrence furnace, Hanging Rock, Lawrence county.
2	do	do	From 2 tons of ore at drift	"Gray limestone" "kidney" (C. M.).	1209	Hecla furnace, Hanging Rock, Lawrence county.
3	do	do	From 5 tons of ore at drift	do	1210	do
4	do	do	Selected lumps from stock pile at Hecla furnace.	"Yellow kidney" (C. M.).	1211	do
5	do	do	From wagon-load of ore at Hecla furnace	"Limestone ore" (C. M.).	1212	do
6	do	do	From 10 tons of ore at Hecla furnace	Mixed roasted ore (C. M.).	1213	do
7	do	do	From 2 tons of ore at furnace	Hematite, "black-band" (C. M.).	1220	Peterson's ore, Olive furnace, near Webster, Lawrence county.
8	do	do	From 1 ton of ore at furnace	do	1221	do
9	do	do	Selected lumps from 15 tons of ore near drift from bottom vein.	"Gray carbonate" (C. M.).	1228	Davis ore, Jackson, Lawrence county
10	do	do	Selected lumps from 15 tons of ore near drift from 2d vein.	do	1229	do
11	do	do	Selected lumps from 15 tons of ore near drift from 3d vein.	do	1230	do
12	do	do	Selected lumps from 15 tons of ore near drift from 4th vein.	do	1231	do
13	do	do	Selected lumps from 15 tons of ore near drift from 5th vein.	do	1232	do
14	do	do	From pile of ore at drift	"Red Hudson" (C. M.).	1235	Hudson drift, near Monroe furnace, Lawrence county.
15	do	do	do	"Gray Hudson" (C. M.).	1236	do
16	do	do	From car-load of ore at furnace	"Red limestone" (C. M.).	1237	Washington furnace, Lawrence county.
17	do	do	From wagon-load of ore at furnace	"Gray limestone" (C. M.).	1238	do
18	do	do	Selected lumps from stock pile at furnace	"Red limestone" "kidney" (C. M.).	1239	do
19	do	do	do	"Gray limestone" (C. M.).	1240	do
20	do	do	From stock pile at furnace	Mixed roasted (C. M.).	1241	do
21	do	do	Selected lumps from stock pile at furnace	"Red limestone" "kidney" (C. M.).	1222	Monroe furnace, Jackson county
22	do	do	do	"Hematite kidney" (C. M.).	1223	do
23	do	do	do	"Top hill kidney" (C. M.).	1224	do
24	do	do	do	"Block ore" (C. M.)	1225	do
25	do	do	do	do	1226	do
26	do	do	From stock pile at furnace	Mixed roasted ore (C. M.).	1227	do
27	do	do	do	"Red limestone" (C. M.).	1233	do
28	do	do	do	"Gray limestone" (C. M.).	1234	do
29	do	do	From car-load of ore at Star furnace	Earthy limonite (C. M.)	1242	Ray's ore, Byer's station, Jackson county.
30	do	do	From 500 tons of ore at furnace	"Block ore" (C. M.)	1243	Milton furnace, near Hamden, Jackson county.
31	do	do	From stock pile at furnace	do	1244	do
32	do	do	From 10 tons of ore at drift	"Red limestone" (C. M.).	1245	Swaringen farm, near Milton, Jackson county.
33	do	do	Selected lumps from 10 tons of ore at drift	Soft "red limestone" (C. M.).	1246	do
34	do	do	From 15 tons of ore at stripping	Block ore (C. M.)	1247	do
35	do	do	Selected lumps from stock pile	"Fine block" (C. M.)	1214	Scioto furnace, Scioto county
36	do	do	do	"Big red block" (C. M.).	1215	do
37	do	do	do	"Little sand block" (C. M.).	1216	do
38	do	do	do	"Big sand block" (C. M.).	1217	do
39	do	do	do	"Little red block" (C. M.).	1218	do
40	do	do	do	"Flag ore" (C. M.)	1219	do
41	do	do	From 500 tons of ore at furnace	Limonite (C. M.) "Limestone ore".	1248	Gore furnace, Hocking county
42	do	do	From stock pile at furnace (broken and screened, ready for use).	Limonite (C. M.) (roasted), "Limestone ore"	1249	do

TABLE 25.—*Partial analyses of iron ores*—Continued.

NORTH CAROLINA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.691	56.46	Specific gravity, 3.805	0.702	57.33		1.224	60
0.994	51.94		1.010	52.76		1.914	61
0.019	51.66		0.019	52.23		0.037	62
0.009	63.80		0.009	64.04		0.014	63
0.041	62.78	S 1.000 p. ct	0.041	63.23	S 1.007 p. ct	0.065	64
0.016	50.63	S 0.076 p. ct	0.016	50.77	S 0.076 p. ct	0.032	65
0.018	48.92		0.018	49.06		0.037	66
0.029	26.96	Cu. 0.34 p. ct	0.029	27.20	Cu. 0.34 p. ct	0.108	67

OHIO.

0.155	40.59		0.157	41.15		0.382	1
0.049	34.27	TiO_2 absent	0.049	34.39	TiO_2 absent	0.143	2
0.150	41.40	do	0.152	41.90	do	0.362	3
0.317	32.97		0.320	33.34		0.961	4
0.144	33.29	Mn. present; TiO_2 trace	0.144	33.39	Mn. present; TiO_2 trace	0.433	5
0.154	42.91		0.154	43.00		0.359	6
0.568	45.68	TiO_2 absent	0.597	47.98	TiO_2 absent	1.240	7
0.652	46.17	do	0.678	48.05	do	1.410	8
0.429	35.17		0.430	35.25		1.220	9
0.270	34.07		0.273	34.47		0.792	10
0.249	23.99		0.250	24.11		1.040	11
0.344	32.03		0.345	32.13		1.070	12
0.216	17.97		0.217	18.02		1.200	13
0.279	53.82		0.285	54.94		0.518	14
0.172	23.68		0.172	23.72		0.726	15
0.199	54.89		0.204	56.24		0.363	16
0.211	32.59		0.212	32.70		0.647	17
0.156	39.49		0.157	39.78		0.395	18
0.074	34.62		0.074	34.71		0.214	19
0.307	50.93		0.307	51.21		0.603	20
0.145	49.32	Mn. present; TiO_2 trace	0.147	50.03	Mn. present; TiO_2 trace	0.294	21
0.167	43.23	do	0.171	44.16	do	0.386	22
0.479	31.66	TiO_2 absent	0.484	31.29	TiO_2 absent	1.510	23
0.320	41.85		0.325	42.54		0.765	24
0.333	42.26		0.340	43.12		0.788	25
0.345	37.94	Mn. present; TiO_2 absent	0.346	38.09	Mn. present; TiO_2 absent	0.909	26
0.240	47.23		0.244	48.02		0.508	27
0.151	36.56		0.152	36.73		0.413	28
0.377	30.98		0.381	31.31		1.220	29
0.250	31.56		0.251	31.74		0.792	30
0.197	46.12		0.199	46.57		0.427	31
0.127	51.46		0.130	52.56		0.247	32
0.072	51.97		0.073	53.00		0.139	33
0.665	43.63		0.670	43.98		1.520	34
0.211	49.71		0.214	50.44		0.424	35
0.579	40.42		0.586	40.89		1.430	36
0.252	36.19	TiO_2 absent	0.256	36.75	TiO_2 absent	0.696	37
0.420	39.73		0.426	40.29		1.060	38
0.515	39.61		0.529	40.70		1.300	39
0.130	34.43		0.131	34.62		0.378	40
0.211	44.34		0.216	45.46		0.476	41
0.186	39.71		0.188	40.09		0.468	42

TABLE 25.—*Partial analyses of iron ores*—Continued.

OHIO—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
43	King	Willis	From 9 tons of ore at furnace, said to be poorer than average.	"Blackband" (C. M.)	1250	Orbiston furnace, Athens county
44	do	do	From 200 tons of ore at furnace	Limonite (C. M.) "Buchtel ore".	1251	do
45	do	do	From 5 car-loads of ore at Creola	Limonite (C. M.) "Dunkel ore".	1252	Dunkel ore, Creola furnace, Vinton county.
46	do	do	From ½ car-load of ore at furnace	Carbonate? (C. M.)	1253	Eagle furnace, Radclift district, Vinton county.
47	do	do	From 2 tons of ore at drift	Hematite (C. M.)	1254	Burline banks, Eagle furnace, Vinton county.
48	do	do	From 4 car-loads of ore at Eagle furnace	Limonite (C. M.)	1255	Burline banks and Tarr Farm furnace, Vinton county.
49	do	do	From 1 car-load of ore at Eagle furnace	Carbonate oolitic (C. M.).	1256	do
50	do	do	From 500 tons of ore at Double XX furnace	Limonite (C. M.) (roasted).	1257	"Pat. Moore farm", Shawnee furnace, Perry county.
51	do	do	From 50 tons of ore at furnace	Blackband (C. M.)	1258	Iron point, New York furnace, Shawnee, Perry county.
52	do	do	do	Limonite (C. M.)	1259	do
53	do	do	From 100 tons of ore at furnace	Blackband (C. M.)	1260	Bowman farm, near Shawnee, Perry county.
54	do	do	From 3 tons of ore at mine	Limonite (C. M.)	1261	do
55	do	do	From unroasted lumps in 500 tons of roasted ore	do	1262	Donnelly bank, Moscabala, Perry county.
56	do	do	From unroasted lumps in pile of roasted ore	do	1263	do
57	do	do	From 100 tons of ore at Junction City	Carbonate (C. M.)	1264	J. McLaughlin's drift, Junction city, Perry county.
58	do	do	From 1 ton of ore at Junction City	Carbonate kidney (C. M.).	1265	do
59	do	do	From wagon-load of ore at Frazeysburg	Limonite (C. M.)	1266	Goff bank, Frazeysburg, Muskingum county.
60	do	do	From 2 wagon-loads of ore at Frazeysburg	do	1267	McGinnis bank, Frazeysburg, Muskingum county.
61	do	do	From 1 wagon-load of ore at Frazeysburg	Carbonate (C. M.)	1268	Millstead bank, Frazeysburg, Muskingum county.
62	do	do	From 3 tons of ore at mine	Limonite (C. M.)	1269	McDonald's bank, Frazeysburg, Muskingum county.
63	do	do	From 10 tons of ore at shaft	"Blackband" (C. M.) (roasted).	1291	Todd, Wells & Co., Mineral ridge, Columbiana county.
64	do	do	From 50 tons of ore at mine	"Blackband" (C. M.)	1292	do
65	do	do	From 100 tons of ore at shaft	do	1293	John Henry, Mineral ridge, Columbiana county.
66	do	do	From 100 tons of ore at mine	"Blackband" (C. M.) (roasted).	1294	do
67	do	do	From 100 tons of raw ore at mine	Limonite and carbonate (C M.).	1295	Cherry Valley Iron Company, near New Lisbon, Columbiana county.
68	do	do	From 25 tons roasted ore at mine	"Kidney" (C. M.) (roasted).	1296	do
69	do	do	From face of ore 75 paces long	Carbonate and limonite (C. M.).	1297	William Dennan's, near New Lisbon, Columbiana county.
70	do	do	From 50 tons of ore at mine	Kidney (C. M.) (roasted).	1298	do
71	do	do	From 200 tons of ore at mine	Carbonate and limonite (C. M.).	1299	A. G. Smith's, near New Lisbon, Columbiana county.
72	do	do	From 1 car-load of ore screened and ready for shipment.	Kidney (C. M.) (roasted).	1300	do
73	do	do	From pieces near old pits	Carbonate and limonite (C. M.).	1270	Near Zoar, Tuscarawas county
74	do	do	From ½ ton of ore at small opening near canal	do	1271	Heit's farm, near Dover, Tuscarawas county.
75	do	do	From a few kidneys dug from bank	do	1272	Winkler's farm, near Dover, Tuscarawas county.
76	do	do	From 200 tons of ore at Dover furnace	Carbonate with limonite (C. M.).	1273	Anman farm, near Dover, Tuscarawas county.
77	do	do	From face of ore in pit	Limonite (C. M.) "mountain ore".	1274	Groebel farm, near Dover, Tuscarawas county.
78	do	do	From 300 tons of ore at mine	"Blackband" (C. M.)	1275	Bähler's farm, near Dover, Tuscarawas county.
79	do	do	From 200 tons of ore from same opening as No. 1275.	"Blackband" (C. M.) (roasted).	1276	do
80	do	do	From 200 tons of ore from drift	do	1277	do
81	do	do	From 50 tons of ore from same drift as No. 1277	Carbonate (C. M.) "mountain ore".	1278	do
82	do	do	From 10 tons of ore at mine	Limonite (C. M.) "mountain ore".	1279	do
83	do	do	From face of ore 5 feet thick in mine	Blackband (C. M.)	1280	Dover Furnace hill, Fairfield, Tuscarawas county.
84	do	do	From 5 tons of ore from same drift as No. 1280	Blackband (C. M.) (roasted).	1281	do
85	do	do	From 50 tons of ore at mine	do	1282	Hugh Kelley's, Fairfield, Tuscarawas county.
86	do	do	From 50 tons of ore from same opening as No. 1285.	"Mountain ore" (C. M.) (roasted).	1283	do
87	do	do	From 100 tons of ore at mine	"Blackband" (C. M.)	1284	do
88	do	do	From 50 tons of ore at mine (see No. 1283)	"Mountain ore" (C. M.).	1285	do
89	do	do	From 100 tons of ore from open cut	"Blankband" (C. M.)	1286	Dye bank, near Wolf station, Tuscarawas county.
90	do	do	From 50 tons of ore from drift	"Blackband" (C. M.) (roasted).	1287	do
91	do	do	From face where bed is 2 feet 8 inches thick	"Blackband" (C. M.)	1288	do
92	do	do	From face where bed is 5 feet 2 inches thick	do	1289	Wyan's farm, Wolf station, Tuscarawas county.
93	do	do	From 100 tons of ore from same bed as No. 1289	"Blackband" (C. M.) (roasted).	1290	do

TABLE 25.—*Partial analyses of iron ores*—Continued

OHIO—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.333	35.08		0.340	35.84		0.949	43
1.450	28.63		1.480	29.23		5.065	44
0.174	41.62		0.177	42.27		0.418	45
0.233	35.57		0.234	35.69		0.655	46
0.112	52.08		0.116	54.06		0.215	47
0.205	47.50		0.205	47.50		0.432	48
0.080	34.68		0.082	35.33		0.231	49
0.239	44.29		0.240	44.44		0.540	50
0.288	34.41		0.289	34.51		0.837	51
1.132	46.34		1.148	46.98		2.443	52
0.567	31.96		0.582	32.79		1.774	53
0.884	42.78		0.898	43.45		2.066	54
3.106	34.99		3.207	36.14		8.877	55
1.001	30.23		1.021	30.84		3.311	56
0.144	38.73		0.145	38.95		0.372	57
0.102	36.64		0.102	36.81		0.278	58
0.532	51.86		0.533	52.00		1.026	59
0.281	37.70		0.287	38.46		0.745	60
0.181	32.41		0.183	32.79		0.558	61
0.137	52.17		0.137	52.30		0.263	62
0.224	50.62		0.225	50.77		0.443	63
0.150	30.00		0.152	33.33		0.500	64
0.182	30.72		0.184	31.07		0.592	65
0.398	52.53		0.399	52.63		0.758	66
0.516	38.21		0.521	38.55		1.351	67
0.428	46.07		0.441	47.44		0.929	68
0.468	39.77		0.474	40.31		1.177	69
0.468	48.34		0.471	48.63		0.968	70
0.417	38.04		0.422	38.54		1.096	71
0.370	38.55		0.373	38.86		0.960	72
0.160	26.89		0.161	27.10		0.595	73
0.188	39.09	TiO_2 absent	0.190	39.50	TiO_2 absent	0.486	74
0.824	40.65	TiO_2 trace	0.838	41.34	TiO_2 trace	2.027	75
0.184	34.15		0.186	34.39		0.539	76
0.604	32.36		0.620	32.24		1.867	77
0.195	26.31		0.198	26.71		0.741	78
0.350	44.07	TiO_2 absent; Mn. present	0.351	44.14	TiO_2 absent; Mn. present	0.794	79
0.169	27.32		0.171	27.66		0.619	80
0.705	34.68	TiO_2 absent	0.715	35.38	TiO_2 absent	2.033	81
0.988	43.09		1.021	44.54		2.293	82
0.171	23.95		0.173	24.24		0.714	83
0.422	40.91		0.422	40.95		1.032	84
0.314	41.12	TiO_2 absent; Mn. present	0.315	41.25	TiO_2 absent; Mn. present	0.764	85
0.702	45.36		0.704	46.46		1.548	86
0.159	27.56	TiO_2 absent	0.160	27.75	TiO_2 absent	0.577	87
0.326	29.52		0.328	29.66		1.143	88
0.160	25.20		0.162	25.49		0.635	89
0.264	42.18	Mn. present	0.264	42.21	Mn. present	0.626	90
0.161	23.90	do	0.163	24.21	do	0.674	91
0.266	26.32		0.270	26.73		1.011	92
0.312	44.48		0.313	44.57		0.701	93

TABLE 25.—*Partial analyses of iron ores*—Continued.

OREGON.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
1	Whitfield	Putnam	From 150 tons of ore at Oswego furnace	Limonite	1165	Prosser, Oswego furnace, Clackamas county.
2	do	do	Selected pieces from pile of ore in stock house at Oswego furnace.	Micaceous variety	1167	do
3	do	do	From 60 tons of ore at Oswego furnace	Limonite	1166	Patton, Oswego furnace, Clackamas county.

PENNSYLVANIA.

1	Whitfield	Willis	From 40 tons on cars, from along a face 300 feet north and south.	Magnetite	1401	Big hill, upper level, Cornwall mines, Lebanon county.
2	do	do	From 15 tons, loaded for shipment, from south side.	do	1402	Big hill, middle level, Cornwall mines, Lebanon county.
3	do	do	From 5 tons from along face of 150 feet in southwest cut.	do	1403	Middle hill, southwest cut, Cornwall mines, Lebanon county.
4	do	do	From 30 tons, on cars, from along a face of 100 feet east and west.	do	1404	Middle hill, center cut, Cornwall mines, Lebanon county.
5	do	do	Along entire northern face of cut about 300 feet east and west.	do	1405	Grassy hill, north face, Cornwall mines, Lebanon county.
6	do	do	From 50 tons on cars, mined along eastern face of lowest cut about 450 feet north and south.	do	1406	Middle hill, eastern face, Cornwall mines, Lebanon county.
7	do	do	From 5 tons of ore in copper house	do	1407	Middle hill, copper ore, Cornwall mines, Lebanon county.
8	do	do	From about 800 tons at Reading Iron Works	do	1411	Fritz island, near Reading, Berks county.
9	do	do	From 1,200 tons at mine	do	1413	Warwick, Boyertown, Berks county
10	do	do	From 300 tons at mine; "black ore"	do	1414	Gabel's mine, Boyertown, Berks county.
11	do	do	From 1,000 tons at mine; Gabel vein	do	1415	do
12	do	do	From about 100 tons at upper and lower Phœnix inclines.	do	1416	Phœnix, Boyertown, Berks county
13	do	do	From 500 tons at mine, from the Eckert vein	do	1417	California, Boyertown, Berks county
14	do	do	From 500 tons at mine, from the Rhoades vein	do	1418	do
15	do	do	From 10 tons at mine	do	1419	Rowes' mine, Barto station, Berks county.
16	do	do	From 40 tons on cars near the mine	do	1420	Wheatfield, near Fritztown, Berks county.
17	do	do	From 20 tons at mine	do	1424	Jones' north shaft, Springfield, Berks county.
18	do	do	From 10 tons at mine	Magnetite (decomposed).	1425	Jones' south shaft, Springfield, Berks county.
19	do	do	From 5 tons of ore at shaft	Magnetite	1421	French creek, shaft No. 1, Knauertown, Chester county.
20	do	do	From 15 tons at mine	do	1422	French creek, shaft No. 2, Knauertown, Chester county.
21	do	do	From 30 tons at mine	do	1423	Hopewell No. 4, Saint Mary's, Chester county.
22	do	do	From 2 car-loads of ore at Dillsburg	do	1432	Bell, Dillsburg, York county
23	do	do	From 75 tons at the depot at Dillsburg	do	1433	Longnecker, Dillsburg, York county
24	do	do	From 50 tons at the depot at Dillsburg	do	1434	Underwood, Dillsburg, York county

RHODE ISLAND.

1	Pitman	Willis	From mine	Magnetite	991	Iron Hill mine, Cumberland, Providence county.

SOUTH CAROLINA.

1	Pitman	Willis	From 1 ton of ore from shaft	Magnetite	196	Brockley bank, near Gaffney's, Spartanburgh county.
2	do	do	From 3 tons of ore from open cut	do	197	Red ore opening, near Gaffney's, Spartanburgh county.
3	do	do	Numerous specimens near old pits and trenches	do	199	Lee bank, near Black's Station, York county.
4	do	do	From 2 tons of ore mined near surface several years ago.	do	200	Plantation bank, Black's Station, York county.
5	do	do	From 3-foot vein	Magnetite and hematite.	401	Silver Mountain bank, Black's Station, York county.

TENNESSEE.

1	King	Chauvenet	From stock pile at South Pittsburgh furnaces	Fossil (gravel)	272	Green's, Sec. 15, T. 4, R. 2 W., James county.
2	White	do	From pile at incline on railroad at Green's mine	Fossil	276	do
3	do	do	From pile at incline on switch at Green's mine	Fossil (gravel)	277	do
4	King	do	From small pit, 10 feet deep, at mine	Fossil	273	Ragon's, T. 4, R. 2 W., James county
5	White	do	From stock pile of Chattanooga Iron Company, Chattanooga.	do	283	Burns, Chattanooga district (Coltewah), James county.
6	King	do	From stock pile at Wolf's switch	do	274	Smith's, T. 4, R. 2 W., Bradley county
7	White	do	From pile of ore on railroad	do	275	Hinch, T. 4, R. 2 W., Bradley county

TABLE 25.—*Partial analyses of iron ores*—Continued.

OREGON.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.666	44.71	TiO_2 0.51 p. ct	0.700	47.01	TiO_2 0.54 p. ct	1.490	1
0.392	54.19		0.398	55.03		0.723	2
0.576	45.40		0.609	48.02		1.269	3

PENNSYLVANIA.

0.013	49.53		0.013	49.68		0.026	1
0.017	50.93		0.017	51.19		0.033	2
0.011	56.67		0.011	56.72		0.019	3
0.019	44.56		0.019	44.76		0.043	4
Trace.	59.74		Trace.	60.07			5
0.009	53.80		0.009	53.95		0.017	6
		Cu 11.62 p. ct.; not analyzed for Fe and P			Cu 11.67 p. ct		7
0.029	41.84		0.029	42.28		0.069	8
0.069	45.10		0.069	45.15		0.153	9
0.038	47.43		0.038	47.63		0.080	10
0.039	37.73		0.039	37.84		0.103	11
0.022	48.68		0.022	49.03		0.045	12
0.037	54.97		0.037	55.32		0.067	13
0.045	37.57		0.045	37.72		0.119	14
0.110	54.42		0.110	54.52		0.202	15
0.025	37.88		0.025	38.23		0.066	16
0.027	45.26		0.027	45.45		0.060	17
0.025	51.32		0.025	52.24		0.049	18
0.033	52.64		0.034	53.70		0.083	19
0.040	56.13		0.040	56.25		0.092	20
0.030	57.29		0.030	57.94		0.068	21
0.016	39.55		0.016	39.71		0.040	22
0.016	43.63		0.016	43.70		0.037	23
0.018	44.10		0.018	44.23		0.041	24

RHODE ISLAND.

0.026	32.80	S 0.057 p. ct.; TiO_2 9.35	0.026	32.84	S 0.057 p. ct.; TiO_2 9.86	0.079	1

SOUTH CAROLINA.

0.011	58.34	Specific gravity, 4.383	0.011	58.52		0.019	1
0.172	37.79	Specific gravity, 3.544	0.172	37.82		0.455	2
0.014	52.16	S 0.127 p. ct.; specific gravity, 4.087	0.014	52.34	S 0.127 p. ct	0.026	3
0.002	54.65	Specific gravity, 4.232	0.002	54.80		0.004	4
0.180	39.24	TiO_2 36.67 p. ct.; insoluble, 38.51 p. ct.; specific gravity, 3.577.	0.181	39.43	TiO_2 36.85 p. ct.; insoluble, 38.70 p. ct	0.459	5

TENNESSEE.

0.058	55.30	Specific gravity, 4.278	0.058	55.51		0.105	1
0.153	50.69	Specific gravity, 4.005	0.154	50.92		0.302	2
0.056	59.03	Specific gravity, 4.479	0.056	59.24		0.095	3
0.128	47.90	Specific gravity, 3.880	0.129	48.17		0.267	4
0.139	48.86	Specific gravity, 4.037	0.140	49.21		0.284	5
0.127	44.88	Specific gravity, 3.742	0.128	45.27		0.283	6
0.214	54.35	Specific gravity, 4.170	0.215	54.61		0.394	7

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
8	King	Chauvenet	From short tunnel, 10 feet deep, on vein	Fossil	278	Coker's, Chattanooga district, Hamilton county.
9	do	do	From upper 21½-inch vein, south outcrop	do	279	do
10	do	do	From pile at edge of small pit ready for shipment.	do	280	Lowe's, Chattanooga district, Hamilton county.
11	do	do	From 2 feet of exposed vein	do	281	do
12	do	do	From stock pile at Chattanooga furnace, Chattanooga.	do	282	Kendrick's, near Half Moon island, Meigs county.
13	White	do	From 10 tons from cut on vein	do	284	Solomon's, Oakdale, Roane county
14	do	do	From pile at cut on vein near old shaft, ½ mile southeast of furnace.	do	285	Oakdale, Oakdale, Roane county
15	do	do	From stock pile at Oakdale Iron Works; ore from bottom of 60-foot shaft on vein.	do	286	do
16	do	do	From main vein, 2½ miles northeast of Rockwood	do	287	Piatt's, Rockwood, Roane county
17	King	do	From 50 tons from main vein	do	288	Rockwood's (Piatt's), Rockwood, Roane county.
18	do	do	Along 4-foot upper soft seam at center of east slope of hill.	do	289	J. D. Robert's, Kingston, Roane county
19	do	do	From pile of stripped ore along 50 feet of vein-face.	do	290	Robert's, Kingston, Roane county
20	do	do	From main vein along 50 feet at two points	do	291	Brown's, Rockwood, Roane county
21	do	do	From stock pile of 3 tons from 12-inch vein	do	292	do
22	do	do	From left-hand wall, top of main entry, northeast end of mine.	do	293	Hill & Tarwater, Rhea Springs, Rhea county.
23	do	do	Across 4-foot seam and over whole northeast end of main entry.	do	294	do
24	White	do	From whole vein	do	295	do
25	do	do	From top and sides of tunnel, southwest side, north pit, on old mine diggings.	Limonite	300	Wayne, Waynesborough, Wayne county
26	do	do	From exposed masses and streaks, and from loose lumps in old pit.	Hematite	501	Marion furnace, Clifton, Wayne county
27	King	do	From lumps left in old detritus piles	Limonite	502	do
28	White	do	Selected sample from detritus mounds at bank	do	296	Hagen's, Lawrenceburg, Lawrence county.
29	do	do	From 20-foot horizontal cut along working-face at west end.	do	297	Napier's, near Napier furnace, Lawrence county.
30	do	do	From 3 tons screened ore from all sides of pit	do	298	do
31	do	do	From stock pile at Napier furnace	do	299	do
32	Whitfield	Willis	From ore thrown out of several shafts	do	479	Old Tennessee copper mine, Ducktown, Polk county.
33	do	do	From ore thrown out of shafts	do	480	London copper mine, Ducktown, Polk county.
34	do	do	From exposure of ore in pit	do	482	Upper opening, Gee Creek gap, Polk county.
35	do	do	do	do	483	Lower opening, Gee Creek gap, Polk county.
36	do	do	From angular fragments in deep gullies	Specular	481	Sheriff William Burke's, near Athens, McMinn county.
37	King	do	From bank	Fossil	973	Hill's ore-bank, near Athens, McMinn county.
38	do	do	From numerous pieces near White Cliffs springs	Limonite	974	R. G. Patty's land, near Athens, McMinn county.
39	do	do	From ore from three shafts	do	975	Charles Cates', near Athens, McMinn county.
40	do	do	From bank	Specular	976	Stone Dye bank, near Athens, McMinn county.
41	Whitfield	do	From massive outcrop of vein	Limonite	484	Opening near Jalapa, Monroe county
42	do	do	From ore apparently thrown from test pit	do	485	Jerome Griffith's, near Jalapa, Monroe county.
43	do	do	From ore mined in small opening	do	486	Donnelly bank, Tellico, Monroe county.
44	do	do	From 500 tons of ore at bank	do	487	Hale bank, Tellico, Monroe county
45	do	do	From fragments at small opening	do	488	Opening near Tellico furnace, Monroe county.
46	do	do	From ore lying by small pit	do	489	Outcrop on Anderson's land, Ball Play, Monroe county.
47	King	do	From ore thrown out at pit	do	490	J. H. Rogers, Happy valley, Aram's creek, Blount county.
48	do	do	From ore in old pits	do	491	William Feezelle's property, Codes Creek, Blount county.
49	do	do	From pieces at small opening	do	492	Abram's Creek bank, near Little Tennessee river, Blount county.
50	do	do	From bank	do	493	Mount bank, near Maryville, Blount county.
51	do	do	From pile of ore for roasting	do	494	Widow Kerr's land, near Maryville, Blount county.
52	do	do	do	do	495	Wilson bank, near Maryville, Blount county.
53	do	do	From small pile of roasted ore at bank	Limonite (roasted)	496	do
54	do	do	From stock pile at Maryville	Limonite	497	Seaton bank, near Maryville, Blount county.
55	do	do	do	do	498	Carpenter bank, near Maryville, Blount county.
56	do	do	From exposure of ore in pit	Fossil	499	Peters & Mowry bank, near Knoxville, Knox county.
57	do	do	From 3 tons from small tunnel	do	500	Opening near John Hills, Lone mountain, Anderson county.
58	do	Chauvenet	From loose lump of fine ore on surface of old detritus piles.	Limonite	503	Decatur furnace, Clifton, Decatur county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.430	31.77	Specific gravity, 3.425	0.432	31.88		1.354	8
0.753	54.76	Specific gravity, 4.121	0.759	55.22		1.375	9
0.248	47.09	Specific gravity, 3.694	0.251	47.68		0.527	10
0.175	48.78	Specific gravity, 3.750	0.177	49.26		0.359	11
0.345	51.63	Specific gravity, 3.914	0.349	52.29		0.668	12
0.595	50.64	Specific gravity, 3.921	0.604	51.39		1.175	13
0.140	46.34	Specific gravity, 3.777	0.141	46.81		0.302	14
0.705	37.03	Specific gravity, 3.574	0.708	37.21		1.904	15
0.920	53.30	Specific gravity, 4.138	0.932	54.00		1.726	16
0.749	55.40	Specific gravity, 4.013	0.761	56.27		1.352	17
0.387	44.02	Specific gravity, 3.411	0.393	44.69		0.879	18
0.426	49.26	Specific gravity, 3.559	0.431	49.86		0.865	19
0.253	52.75	Specific gravity, 3.898	0.257	53.55		0.480	20
0.072	48.65	Specific gravity, 3.869	0.073	49.17		0.148	21
0.766	41.77	Specific gravity, 3.740	0.773	42.17		1.834	22
0.780	50.13	Specific gravity, 3.941	0.790	50.79		1.556	23
0.506	51.71	S 0.109 p. ct.; specific gravity, 4.007. Complete analysis.	0.510	52.11	S 0.110 p. ct	0.979	24
1.084	45.78		1.079	46.01		2.368	25
0.314	54.86	S 0.108 p. ct. Complete analysis	0.319	55.70	S 0.110 p. ct	0.573	26
0.670	50.57		0.678	51.18		1.325	27
0.708	52.43	Specific gravity, 3.695	0.712	52.72		1.350	28
0.340	53.27	Specific gravity, 3.751	0.341	53.44		0.638	29
0.543	49.28	Specific gravity, 3.596	0.547	49.60		1.102	30
0.519	52.61	S 0.070 p. ct.; specific gravity, 3.714. Complete analysis.	0.522	52.88	S 0.070 p. ct	0.987	31
0.030	51.94	Specific gravity, 4.185	0.030	53.93		0.058	32
0.035	48.96	Mn. present; specific gravity, 3.328	0.036	50.48	Mn. present	0.070	33
0.724	45.47		0.735	46.15		1.592	34
1.420	49.40	Specific gravity, 3.616	1.440	50.13		2.874	35
0.044	62.49	Specific gravity, 4.965	0.044	62.53		0.070	36
0.822	51.42		0.835	52.20		1.599	37
0.094	56.79	S 0.089 p. ct.; Mn. present	0.095	57.20	S 0.090 p. ct.; Mn. present	0.166	38
0.032	55.87	S 0.273 p. ct.; Mn. present	0.032	56.21	S 0.275 p. ct.; Mn. present	0.057	39
0.024	65.36		0.024	65.79		0.037	40
1.090	52.74	Specific gravity, 3.690	1.100	53.30		2.067	41
0.870	53.55		0.870	53.62		1.625	42
0.870	45.03	Mn. 1.03 p. ct	0.890	45.87	Mn. 1.03 p. ct	1.932	43
0.445	54.78	S 0.147 p. ct. Complete analysis	0.450	55.22	S 0.148 p. ct	0.815	44
1.530	45.47	Specific gravity, 3.452	1.550	46.11		3.365	45
0.890	46.56		0.900	47.05		1.912	46
0.491	55.48	Specific gravity, 3.712	0.501	56.60		0.885	47
0.938	55.28	Specific gravity, 3.728	0.949	55.95		1.696	48
0.638	50.23	Specific gravity, 3.550	0.650	51.18		1.270	49
1.042	53.85	Mn. 0.41 p. ct.; specific gravity, 3.704	1.059	54.75	Mn. 0.41 p. ct	1.935	50
0.035	57.26	S 0.347 p. ct.; Mn. trace; specific gravity, 3.805	0.035	57.96	S 0.351 p. ct.; Mn. trace	0.061	51
0.143	53.54	S 0.184 p. ct.; specific gravity, 3.644. Complete analysis.	0.147	54.66	S 0.188 p. ct	0.269	52
0.064	63.80	S 0.173 p. ct.; Mn. trace; specific gravity, 4.564	0.064	64.26	S 0.174 p. ct.; Mn. trace	0.107	53
0.104	57.60	S 0.178 p. ct.; Mn. trace	0.105	58.21	S 0.180 p. ct.; Mn. trace	0.181	54
0.059	53.20	S 0.266 p. ct.; Mn. trace; specific gravity, 3.596	0.060	54.21	S 0.271 p. ct.; Mn. trace	0.111	55
1.652	49.89	Specific gravity, 3.946	1.695	50.57		3.311	56
0.522	39.08		0.531	39.76		1.336	57
1.466	49.79		1.490	50.62		2.944	58

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
59	King	Chauvenet	From loose lumps left in pits	Limonite	504	Brownsport furnace, Decatur county
60	do	do	From masses at northwest end of main pit, and from loose lumps thrown from pit.	do	505	Ætna, East fork, Cane creek, Hickman county.
61	do	do	From all accessible parts of old workings	do	506	Mill Creek, Centreville, Hickman county.
62	do	do	From pickings on detritus piles on hill slope and in cuts.	do	507	Piney furnace. Dickson, Dickson county.
63	do	do	From open pits, and from detritus piles	do	508	do
64	do	do	From west bank of Worley furnace property	do	509	Worley, Dickson, Dickson county
65	do	do	From fifteen working faces in main bank	do	510	East bank, Worley furnace, Dickson, Dickson county.
66	do	do	From stock pile of 300 tons at Cumberland furnace.	do	511	Cumberland Furnace banks, Cumberland Furnace, Dickson county.
67	do	do	From five pits on south slope of hill, and from one pit north side of same.	do	512	Bell bank, Cumberland Furnace, Dickson county.
68	do	do	From all parts of bank	do	513	Nye, or Furnace bank, Cumberland Furnace, Dickson county.
69	do	do	From both pits	do	514	Red and Henry Drake banks, Cumberland Furnace, Dickson county.
70	do	do	From all parts of the bank	do	515	Burton bank, Cumberland Furnace, Dickson county.
71	White	do	From stock pile of Rough and Ready furnace	do	518	Rough and Ready banks, Stewart county.
72	do	do	Loose lumps from shaft and from ore in place in main pit.	do	519	Mound banks, Stewart county
73	do	do	Principally from tunnels at west end of bank	do	520	Bellwood bank, Bear Springs, Stewart county.
74	do	do	From head of cut and from piles from whole cut	do	521	West Bellwood bank, Bear Springs, Stewart county.
75	King	do	From pile at Bear Springs furnace	Pipe limonite	522	Pipe bank, Bear Springs, Stewart county.
76	do	do	From three pits	Limonite	523	Race, Graveyard, and East Bellwood, Bear Springs, Stewart county.
77	do	do	From stock pile	do	524	Clark Furnace banks, Stewart county
78	do	do	From exposure of ore in bank	do	525	Fig and Bayley banks, Stewart county.
79	do	do	From working faces of bank	do	526	Banagan and Shurlock, Stewart county.
80	do	do	From 300 to 400 tons at furnace	do	527	"La Grange" and "Sheridan" banks, Stewart county.
81	do	do	From all parts of open cut below 20 feet from surface.	do	528	"La Grange bank," Stewart county
82	do	do	From bank	do	529	"Sheridan" bank, Stewart county
83	do	do	From small pit; "pipe ore"	do	530	Outlaw's, near Indian Mound, Stewart county.
84	do	Willis	From bank	Fossil	905	Sharp's Forge bank, Big Creek gap, Campbell county.
85	do	do	From outcrop	do	906	Opening, Clear Branch, Campbell county.
86	White	Chauvenet	From old stock pile at Old Poplar Springs furnace.	Limonite (burnt)	517	Poplar Springs bank, Poplar Springs, Montgomery county.
87	King	do	From three main ore banks	Limonite	531	Vernon furnace, 18th district, Montgomery county.
88	do	do	From stock pile of 150 tons at Sailor's Rest station.	do	532	Steel's bank, Sailor's Rest station, Montgomery county.
89	do	do	From southeast side of pit; "pipe ore"	do	533	Bryan's bank, Palmyra, Montgomery county.
90	do	Willis	From uppermost of the four beds	Fossil	901	L. J. Stanfield's, Elk Fork valley, Scott county.
91	do	do	From outcrop	do	902	L. J. Stanfield's middle bed, Elk Fork valley, Scott county.
92	do	do	From lowest of the four beds	do	903	L. J. Stanfield's lower bed, Elk Fork valley, Scott county.
93	do	do	From upper bed of ore	do	904	Widow David's farm, Elk Fork valley, Scott county.
94	do	do	From 50 tons of ore at bank	Limonite	907	Vineyard's bank, near Witt's Foundry, Hamblen county.
95	do	do	From stock pile at railroad, 1 mile from bank	do	908	William's bank, near Witt's Foundry, Hamblen county.
96	do	do	From a few large pieces near the main shaft	do	909	G. S. Newman's land, near Sevierville, Sevier county.
97	do	do	From ore apparently mined and left at bank	do	910	Love's Furnace bank, near Sevierville, Sevier county.
98	do	do	From fragments left at old pit	do	912	James Mantooth's land, Sweetwater, Cocke county.
99	do	do	From 100 tons piled at mouth of tunnel	do	913	Opening near station, Wolf creek, Cocke county.
100	do	do	From upper 3 feet of vein	Specular	914	W. R. Smith's land, Wolf creek, Cocke county.
101	do	do	From pieces of ore found on old dumps	Limonite	915	Varner bank, near Hayesville, Greene county.
102	do	do	From about 1 ton of ore left at bank	do	916	Lamb bank, near Hayesville, Greene county.
103	do	do	From pile of ore laid up for roasting	do	917	Stephen's bank, near Hayesville, Greene county.
104	do	do	From about 2 tons of ore at mine	do	918	Green Ridge, south bank, near Greenville, Greene county.
105	do	do	From 1 ton of ore at bank	do	919	Green ridge, east bank, near Greenville, Greene county.
106	do	do	From small pit near Babb's Mill road	do	920	George Babb's, near Greenville, Greene county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.366	40.63		0.376	41.07		0.901	59
0.279	50.03		0.281	50.46		0.558	60
0.303	52.95		0.305	53.34		0.572	61
0.389	51.86		0.393	52.37		0.750	62
0.218	51.00		0.220	51.55		0.427	63
0.434	43.31		0.441	44.05		1.002	64
0.210	47.14		0.213	47.74		0.445	65
0.213	48.08		0.216	48.65		0.443	66
0.464	49.05		0.470	49.66		0.946	67
0.180	55.47		0.182	56.07		0.324	68
0.341	46.50		0.345	47.10		0.733	69
0.150	46.90		0.152	47.52		0.319	70
0.156	50.74		0.159	51.80		0.307	71
0.286	48.87		0.288	49.22		0.585	72
0.235	54.85		0.236	55.18		0.428	73
0.189	50.36		0.190	50.71		0.375	74
0.197	57.55		0.198	57.97		0.342	75
0.129	52.11		0.130	52.43		0.248	76
0.257	49.56		0.258	49.79		0.519	77
0.157	51.34		0.160	51.76		0.310	78
0.177	48.38		0.178	48.72		0.366	79
0.237	50.91	S 0.069 p. ct. Complete analysis	0.238	51.20	S 0.069 p. ct	0.465	80
0.330	52.22		0.333	52.70		0.632	81
0.293	50.94		0.296	51.42		0.575	82
0.197	55.15	S 0.193 p. ct. Complete analysis	0.199	55.64	S 0.195 p. ct	0.358	83
0.559	41.91		0.564	42.31		1.095	84
0.696	51.90		0.704	52.50		1.341	85
0.162	34.68		0.165	35.31		0.467	86
0.659	47.06		0.672	48.01		1.400	87
0.231	52.86		0.234	53.67		0.437	88
0.225	56.07		0.227	56.67		0.401	89
0.729	45.12		0.738	45.43		1.624	90
0.735	41.81		0.740	42.11		1.757	91
0.899	50.13		0.913	50.92		1.793	92
0.395	33.96		0.397	34.15		1.163	93
0.068	52.00		0.069	52.73		0.131	94
0.020	53.81	TiO_2 absent	0.020	54.43	TiO_2 absent	0.037	95
0.060	58.38		0.060	58.66		0.103	96
0.108	39.86	Mn. 10.72 p. ct	0.110	40.52	Mn. 10.72 p. ct	0.271	97
0.209	51.68		0.210	51.97		0.404	98
0.823	50.03	TiO_2 absent	0.827	50.29	TiO_2 absent	1.645	99
0.016	45.68	S 0.399 p. ct. Complete analysis	0.016	45.73	S 0.399 p. ct	0.035	100
1.179	47.57	TiO_2 absent	1.195	48.22	TiO_2 absent	2.478	101
1.376	53.54	Mn. present	1.394	54.25	Mn. present	2.570	102
1.031	48.87	Mn. 6.52 p. ct	1.044	49.49	Mn. 6.52 p. ct	2.110	103
0.099	53.88		0.100	54.22		0.184	104
0.068	48.12		0.069	48.66		0.141	105
0.089	57.33		0.090	57.79		0.155	106

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
107	King	Willis	From scattered pieces of ore on old dump heaps.	Limonite	921	Huffine's bank, near Jonesboro', Washington county.
108	do	do	From large fragments in open cut, "main ore bank."	do	922	Main bank, Embreeville works, Bompas cove, Washington county.
109	do	do	From pit on west side of cove	do	924	"Lead mine," Bompas cove, Washington county.
110	do	do	From bank on west side of cove	do	923	Bank near Embreeville furnace, Bompas cove, Unicoi county.
111	do	do	From an old bank	do	925	Casper bank, Greasy cove, Unicoi county.
112	do	do	From ore at old pits	do	926	Blue Springs bank, headwaters Big Lane, Unicoi county.
113	do	do	From ore in pit nearest top of hill	do	927	Near Dr. Hamum's, Greasy cove, Unicoi county.
114	do	do	From ore at four different openings	do	928	Keener bank, Greasy cove, Unicoi county.
115	do	do	From pieces of ore in old pits	do	930	Big bank, Unicoi county
116	do	do	From pieces of ore at different openings	do	931	Queen Station bank, Elizabethton, Carter county.
117	do	do	From two openings north of river	do	932	Bear Wallow and Cedar Hill banks, Elizabethton, Carter county.
118	do	do	From small openings in field southeast of house.	do	934	Wesley Carden's bank, Elizabethton, Carter county.
119	do	do	From ore thrown out of test pit	do	962	Jas. Dugger's land, Stony Creek, Carter county.
120	do	do	From ore at the bank	do	963	Hurley bank, Stony Creek, Carter county.
121	do	do	From ore thrown out of test pit	do	964	Blevin's bank, Stony Creek, Carter county.
122	do	do	From pieces found at test pit	Specular	965	Maxwell bank, Stony Creek, Carter county.
123	do	do	From stock pile at furnace	Limonite	966	Lips bank, Stony Creek, Carter county.
124	do	do	do	do	967	Hodge bank, Stony Creek, Carter county.
125	do	do	From washed ore at Carter furnace	do	968	Taylor bank, Carter furnace, Stony Creek, Carter county.
126	do	do	From stock pile at Carter furnace	do	969	Ferguson bank, Carter furnace, Stony Creek, Carter county.
127	do	do	do	Limonite and specular.	970	Specular bank, Carter furnace, Stony Creek, Carter county.
128	do	do	do	Limonite	971	Red Shear bank, Carter furnace, Stony Creek, Carter county.
129	do	do	From surface pieces in field west of bank	Specular	972	Cannon bank, Stony Creek, Carter county.
130	do	do	From 5 tons of ore at bank	Limonite	935	Wash Place bank, Little Doe creek, Johnson county.
131	do	do	From ½ ton at Gooden's forge	do	936	Rankine's bank, Little Doe creek, Johnson county.
132	do	do	From a few pieces of ore at bank	do	937	Stout bank, Little Doe creek, Johnson county.
133	do	do	From about 1 ton at Gooden's forge	do	938	Tompkin's bank, Little Doe creek, Johnson county.
134	do	do	do	do	939	Far Mountain bank, Little Doe creek, Johnson county.
135	do	do	From 3 tons at Wagener's forge	do	940	Near Far Mountain bank, Little Doe creek, Johnson county.
136	do	do	From material thrown out by blasting	do	947	Butler's Furnace bank, near Taylorsville, Johnson county.
137	do	do	From scattered pieces of ore at bank	do	948	Slimp's Laurel Fork bank, Taylorsville, Johnson county.
138	do	do	From pieces of ore near openings	do	949	Donnelly's bank, Shaun's cross-roads, Johnson county.
139	do	do	From ore at forge	do	950	Brown's forge, Little mountain, Roane's creek, Johnson county.
140	do	do	From stock pile at furnace	do	951	Mast bank, Mill branch, Roane's creek, Johnson county.
141	do	do	From pieces left at old pits	do	952	Baker bank, Roane's creek, Johnson county.
142	do	do	From pieces in old pits	do	953	Cove bank, Roane's creek, Johnson county.
143	do	do	From pieces found at bank	do	954	Taylor's bank, Dugger's ford, Johnson county.
144	do	do	From small pieces near old pits	Specular	955	Cross mountain, near mouth of Stony creek, Johnson county.
145	do	do	From 3 tons of ore at lower forge	Limonite	956	Armstead Blevin's bank, Shady valley, Johnson county.
146	do	do	From 5 tons of ore at bank	do	958	King bank, Shady valley, Johnson county.
147	do	do	From ore found on Gray's hill	Magnetite	960	Sharp's bank, near Bristol, Sullivan county.
148	do	do	From 200 tons of ore at bank	Limonite	961	Crockett bank, near Bristol, Sullivan county.

UTAH.

1	King	Putnam	From 25 tons ore at Horn Silver smelter, Frisco.	Hematite	1135	Wah-Wah mountains, Beaver county
2	do	do	From 15 tons ore at Horn Silver smelter, Frisco.	Hematite and magnetite.	1136	Mooney's, Wah-Wah mountains, Beaver county.
3	do	do	From a few tons of ore at Frisco smelter	Limonite	1137	Vulcan, Star mining district, Beaver county.
4	do	do	From ore from several prospect holes	Magnetite	1140	Lake Superior, Star mining district, Beaver county.
5	do	do	From 20 tons of ore at Frisco smelter	Limonite	1138	Cave, Bradshaw mining district, Beaver county.
6	do	do	From a few tons of ore at Frisco smelter	Magnetite	1139	Frisco Mining and Smelting Company, Rocky Mountain district, Beaver county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

TENNESSEE—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.308	48.60		0.311	49.15		0.634	107
0.149	57.56		0.151	58.40		0.259	108
0.016	58.59		0.016	59.12		0.027	109
0.715	49.11		0.723	49.65		1.456	110
1.300	50.31		1.318	51.00		2.584	111
0.391	47.71		0.400	48.81		0.820	112
0.194	53.37		0.196	53.83		0.364	113
0.520	53.22	Mn. 0.76 p. ct	0.524	53.66	Mn. 0.77 p. ct	0.977	114
0.880	53.18	Mn. 1.90; TiO_2 absent	0.889	53.75	Mn. 1.93 p. ct.; TiO_2 absent	1.655	115
0.154	57.65	S 0.139 p. ct. Complete analysis	0.156	58.36	S 0.141 p. ct	0.267	116
0.576	55.92	Mn. 0.27 p ct	0.582	56.48	Mn. 0.27 p. ct	1.030	117
0.206	54.03	Mn. 0.36 p. ct	0.207	54.38	Mn. 0.36 p. ct	0.381	118
1.717	52.24	TiO_2 absent	1.753	53.33	TiO_2 absent	3.287	119
0.153	53.95		0.155	54.57		0.284	120
1.595	49.88		1.619	50.63		3.198	121
0.019	59.19	Mn. present	0.019	59.22	Mn. present	0.032	122
1.025	50.09	Mn. 0.21 p. ct	1.031	50.38	Mn. 0.21 p. ct	2.046	123
0.074	34.28	S 0.098 p. ct. Complete analysis	0.075	34.68	S 0.099 p. ct	0.213	124
0.056	49.73	S 0.066 p. ct. Complete analysis	0.057	50.46	S 0.067 p ct	0.113	125
0.280	42.97	SiO_2 24.88 p. ct	0.282	43.23	SiO_2 24.88 p. ct	0.652	126
0.338	53.96	S 0.069 p. ct. Complete analysis	0.339	54.15	S 0.069 p. ct	0.626	127
0.133	55.67	S 0.110 p. ct.; Mn. present	0.135	56.63	S 0.112 p. ct.; Mn. present	0.239	128
0.022	63.84		0.022	63.92		0.034	129
0.214	54.18	S 0.084 p. ct Complete analysis	0.216	54.72	S 0.085 p. ct	0.395	130
1.507	46.54	TiO_2 absent	1.533	47.33	TiO_2 absent	3.238	131
1.273	50.99	Mn. 0.53 p. ct	1.293	51.79	Mn. 0.54 p. ct	2.496	132
0.489	53.35	TiO_2 absent	0.493	53.80	TiO_2 absent	0.917	133
0.255	54.08		0.256	54.35		0.472	134
0.686	56.26		0.691	56.67		1.219	135
1.245	50.74		1.259	51.33		2.454	136
0.336	53.05		0.338	53.36		0.633	137
0.291	53.18		0.294	53.66		0.547	138
0.441	53.78		0.445	54.21		0.820	139
0.768	54.46		0.773	54.86		1.410	140
0.160	57.68	S 0.119 p. ct. Complete analysis	0.161	57.89	S 0.119 p. ct	0.278	141
0.606	46.80	Mn. 7.08 p. ct.; TiO_2 absent	0.611	47.22	Mn. 7.14 p. ct.; TiO_2 absent	1.295	142
0.256	52.83		0.259	53.47		0.485	143
0.015	58.15	Mn. present; TiO_2 absent	0.015	58.22	Mn. present; TiO_2 absent	0.026	144
0.186	52.58	Mn. 1.20 p. ct	0.188	53.11	Mn. 1.21 p. ct	0.354	145
0.092	56.73	Mn. 0.92 p. ct	0.093	57.23	Mn. 0.93 p. ct	0.162	146
0.038	56.47	S 0.163 p. ct. Complete analysis	0.038	56.69	S 0.164 p. ct	0.067	147
0.018	57.63	S 0.196 p. ct.; Mn. present	0.018	58.18	S 0.198 p. ct.; Mn. present	0.031	148

UTAH.

0.012	60.63		0.012	60.76		0.020	1
0.015	57.84		0.015	58.16		0.026	2
0.139	49.61		0.142	50.60		0.280	3
0.237	57.25		0.238	57.51		0.414	4
0.044	39.31		0.044	39.73		0.112	5
0.014	62.23		0.014	62.67		0.022	6

TABLE 25.—*Partial analyses of iron ores*—Continued.

UTAH—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
7	King	Putnam	From outcrop	Magnetite	1141	Marshall, Iron Spring or Magnetic district, Iron county.
8	do	do	do	do	1142	War Eagle, Iron Spring or Magnetic district, Iron county.
9	do	do	do	do	1143	Great Western, Iron Spring or Magnetic district, Iron county.
10	do	do	do	do	1144	Wanderer, Iron Spring or Magnetic district, Iron county.
11	do	do	do	do	1145	Southern Cross, Iron Spring or Magnetic district, Iron county.
12	do	do	do	do	1146	Black Magnetic, Oak Springs, Iron county.
13	do	do	In drift	Hematite	1147	Adelade, Oak Springs, Iron county
14	do	do	From outcrop	Magnetite (lodestone)	1148	Oak Springs, Oak Springs, Iron county
15	do	do	do	Magnetite	1149	Mountain Peak, Oak Springs, Iron county.
16	do	do	do	do	1150	Chesapeake, Oak Springs, Iron county
17	do	do	In drift	Limonite (decomposed magnetite?).	1151	Duncan, Oak Springs, Iron county
18	do	do	Chippings taken across 150 feet of outcrop at point where ore was freest from quartz.	Magnetite	1152	Blowout, Oak Springs, Iron county
19	do	do	Selected pieces from outcrop	do	1153	do
20	do	do	From 30 tons broken ore at mine	Hematite (black)	1155	Black Stallion, East Tintic, Utah county.
21	do	do	From face of stope and broken ore in stope	Hematite	1156	Hematite, Tintic (east of Divide), Utah county.
22	do	do	From broken ore in stope and from face of stope.	Hematite (black)	1157	Sailor Boy, Tintic (east of Divide), Utah county.
23	do	do	From face of stope	Hematite	1158	Queen of the West, Tintic (east of Divide), Utah county.
24	do	do	From 50 tons of ore at mine	Hematite (black)	1159	Billings, Tintic (east of Divide), Utah county.
25	do	do	From 50 tons of ore at stage station, near mines east of Divide.	do	1160	Southern Extension of Dragon, Tintic (west of Divide), Juab county.
26	do	do	From a few pounds of ore near prospect hole	Hematite	1161	Vulcan, Ogden cañon, Weber county
27	do	do	Selected pieces from cut	do	1162	Near Silver Cliff mine, Gold Creek cañon, Weber county.
28	do	do	From about 2,000 tons of ore at foot of hill; sample better than average of the pile.	Specular hematite	1163	Willard, near Willard station, Box Elder county.

VERMONT.

1	Richmond	Benton	From surface fragments near old pit 1 mile north of Caleb Rockwood's house.	Limonite	680	Monkton ore bed, Monkton, Addison county.
2	do	do	From small piles of ore west of ocher works	Manganiferous limonite.	683	Leicester ocher bed, Leicester, Addison county.
3	do	do	From several hundred tons of ore near pit and at ocher works.	Limonite and hematite.	681	Forestdale or Blake, near Brandon, Rutland county.
4	do	do	From piles near roadside at ocher works	Limonite	682	Brandon ore bed, near Brandon, Rutland county.
5	do	do	From small piles of weathered ore north of furnace.	do	684	Granger or Pittsford furnace, Pittsford, Rutland county.
6	do	do	From piles of weathered ore near old workings	do	686	Chipman ore bed, Tinmouth, Rutland county.
7	do	do	From ledge near iron-ore dressing works	Magnetite	688	Bethel Iron Company's mines, Pittsfield, Rutland county.
8	do	do	From piles of dressed ore at dressing works	do	689	do
9	do	do	From piles of ore near old washer	Limonite	685	Godfrey ore bed, Bennington, Bennington county.
10	do	do	From stock piles at furnace	Siderite	687	Tyson furnace, Plymouth, Windsor county.

VIRGINIA.

1	Gooch	Benton	From near shaft on east chute of ore	Micaceous hematite	601	Stapleton, Porridge creek, near Stapleton, Amherst county.
2	do	do	From stopes of main deposit	do	602	do
3	do	do	From stock piles on canal wharf	do	603	do
4	do	do	From 6-inch seam on west wall of deposit in stope above lowest drift 500 feet from mouth of tunnel.	Specular	1012	Stapleton (Maud vein), Porridge creek, near Stapleton, Amherst county.
5	do	do	From 2-foot 6-inch seam of ore on east wall of same stope.	do	1013	Stapleton (Maud veins), Porridge creek, near Stapleton, Amherst county.
6	do	do	From bottom of the two shafts	Micaceous hematite	604	Naylor & Co.'s, Riverville, James river, Amherst county.
7	do	do	From 1-foot seam at bottom of northeast shaft at depth of 115 feet.	Micaceous specular	1018	Naylor & Co.'s No. 6½, Riverville, James river, Amherst county.
8	do	do	From heads of all the drifts, main deposit	Specular and magnetite.	605	Dover & Co.'s No. 11, Riverville, James river, Amherst county.
9	do	do	From further ends of drifts between shafts 2 and 3; also southwest of shaft 3.	Micaceous hematite and magnetite.	606	do
10	do	do	From piles of ore from all parts of cut	Hematite and magnetite.	607	Dover & Co.'s No. 6, Riverville, James River, Amherst county.
11	do	do	From pile of ore near shaft; from shaft at depth of 100 feet.	Micaceous hematite	608	Adams, Scotts & Co.'s No. 13, Riverville, James river, Amherst county.
12	do	do	From head of drift 105 feet deep; also same drift near bottom of shaft.	do	609	Adams, Scotts & Co.'s No. 10½, Riverville, James river, Amherst county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

UTAH—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.248	57.55		0.248	57.61		0.431	7
0.193	61.43		0.193	61.50		0.312	8
0.113	67.81		0.113	67.84		0.167	9
0.264	64.09		0.264	64.18		0.412	10
0.425	61.64		0.426	61.74		0.689	11
0.080	67.09		0.080	67.15		0.119	12
0.182	63.21		0.183	63.60		0.288	13
0.064	65.48		0.064	65.54		0.098	14
0.093	67.09		0.093	67.15		0.139	15
0.059	68.06		0.059	68.13		0.087	16
0.066	59.41		0.067	60.02		0.111	17
0.057	67.31		0.057	67.37		0.085	18
0.038	68.44		0.038	68.50		0.055	19
0.043	52.47		0.044	53.61		0.082	20
0.096	48.21	TiO_2 absent	0.098	49.11	TiO_2 absent	0.199	21
0.142	61.18		0.144	61.94		0.232	22
0.420	51.40		0.434	53.07		0.817	23
0.052	46.46		0.053	47.56		0.112	24
0.259	59.30		0.261	59.81		0.437	25
0.026	45.94		0.026	45.97		0.057	26
0.130	9.89		0.130	9.89		1.315	27
0.038	51.31		0.038	51.31		0.074	28

VERMONT.

0.223	42.05	Mn. 0.65 p. ct.	0.224	42.26	Mn. 0.65 p. ct.	0.530	1
0.223	47.00	Mn. 5.33 p. ct.	0.225	47.34	Mn. 5.37 p. ct.	0.474	2
0.237	51.48		0.238	51.74		0.460	3
0.106	42.05	Mn. 0.08 p. ct.	0.107	42.40	Mn. 0.08 p. ct.	0.252	4
0.268	45.80		0.270	46.10		0.585	5
0.174	42.90		0.176	43.43		0.406	6
0.146	10.10		0.146	10.10		1.446	7
0.026	65.82		0.026	65.83		0.040	8
0.614	45.90		0.623	46.55		1.338	9
0.010	32.24	S 2.158 p. ct. Complete analysis	0.010	32.27	S 2.160 p. ct.	0.031	10

VIRGINIA.

0.096	51.21	TiO_2 present	0.096	51.24	TiO_2 present	0.187	1
0.139	49.89		0.139	49.98		0.279	2
0.129	56.50	TiO_2 present	0.129	56.61	TiO_2 present	0.228	3
0.136	50.38		0.136	50.54		0.270	4
0.206	48.16		0.207	48.36		0.428	5
0.033	48.92		0.033	48.98		0.067	6
0.012	51.14		0.012	51.29		0.023	7
0.103	48.47	S 0.352 p. ct. Complete analysis	0.103	48.50	S 0.352 p. ct.	0.212	8
0.061	54.88	S 0.579 p. ct. Complete analysis	0.061	54.92	S 0.579 p. ct.	0.111	9
0.131	36.10		0.131	36.18		0.363	10
0.051	44.96	TiO_2 present	0.051	45.11	TiO_2 present	0.113	11
0.095	40.51		0.095	40.58		0.235	12

TABLE 25.—*Partial analyses of iron ores*—Continued.

VIRGINIA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
13	Gooch	Benton	From across 6½ feet thickness of soft ore at bottom of shaft 105 feet below surface.	Specular	697	Adams, Scotts & Co.'s, No. 10½, Riverville, James river, Amherst county.
14	do	do	From pile of ore at mouth of shaft ready for shipment; came from head of drift at depth of 120 feet.	Micaceous hematite	698	Adams, Scotts & Co.'s No. 11, Riverville, James river, Amherst county.
15	do	do	From across the outcrop (60 feet)	Ferruginous schist	1014	Slippery Gut outcrop, Dr. Mundy's land, James river, Amherst county.
16	do	do	From head of drift on level with tunnel; thickness of ore from 10 inches to 1 foot.	Specular "blue ore"	1015	Second vein east of Furnace vein, Dr. Mundy's land, Old Elk creek, Amherst county.
17	do	do	From piles of ore from head of drift 60 feet below the surface and 125 feet northeast of shaft.	Specular	1016	First vein east of Furnace vein, Dr. Mundy's land, Old Elk creek, Amherst county.
18	do	do	From stope 20 feet from shaft; thickness sampled, 8 feet.	Limonite	1017	Brown hematite mine, Dr. Mundy's land, Amherst county.
19	do	do	From various parts of the 160-foot drift	Micaceous hematite	610	Greenway, Greenway, James river, Nelson county.
20	do	do	From drift 50 feet below surface	Limonite	611	Otter river, Otter River station, Campbell county.
21	do	do	From pile of roasted ore at furnace	Limonite (roasted)	618	Oxford Furnace banks, Campbell county.
22	do	do	From cross-cut ½ mile northeast of Wright's mill.	Limonite and hematite.	619	Archer's Creek property, near Mount Athos station, Campbell county.
23	do	do	From pit ¾ mile northeast of Wright's mill on William's land.	do	620	do
24	do	do	From pit ¾ mile northeast of Pettigrew's house on Neighbor's land.	do	621	do
25	do	do	From pit 100 yards east of No. 621 on Pettigrew's land.	do	622	do
26	do	do	From pit 1 mile north of No. 621 on Stone's land.	do	623	do
27	do	do	From 75 tons of ore from 65-foot level	Limonite	1019	Red belt, Mount Athos station, Appomattox county.
28	do	do	From across 20 feet of the bed, avoiding intermingled clay and sand.	do	1020	Atlantic, Mississippi and Ohio railroad track, Mount Athos station, Campbell county.
29	do	do	From five shafts in northerly part of mine	Magnetite	612	Pittsville, Pittsylvania and Franklin railroad, Pittsylvania county.
30	do	do	From seven shafts in southern and central part of mine.	do	613	do
31	do	do	From two shafts in central part of mine	do	614	do
32	do	do	From old pit, ½ mile north of railroad station, on Mrs. Bett's land.	Magnetite and limonite.	617	North Garden, Garden station, Albemarle county.
33	do	do	From three new shafts on westerly deposit 10 to 20 feet deep.	Magnetite	615	Rocky Mount, Franklin court-house, Franklin county.
34	do	do	From two shafts on easterly deposit 20 to 30 feet deep.	do	616	do
35	do	do	From ore from two test pits	Hematite and magnetite.	624	Semi-magnetic bank, near Wytheville, Wythe county.
36	do	do	From pile of washed ore	Limonite	625	Carter bank, Cedar run, Wythe county.
37	do	do	From open cut now worked	do	626	Johnson bank, Little Red Island creek, Wythe county.
38	do	do	From excavation in bank of creek	do	627	Hurst bank, Little Red Island creek, Wythe county.
39	do	do	From piles of washed ore at furnace	do	630	Walton Furnace bank, near Walton furnace, Wythe county.
40	do	do	From excavation just north of mouth of tunnel	do	631	Glade bank, near Wytheville, Wythe county.
41	do	do	From pile of washed ore at furnace	do	634	Speedwell Furnace bank, Wythe county.
42	do	do	From pile of washed ore at washer	do	635	Ravenscliffe Furnace bank, Sayers & Oglesby furnace, Wythe county.
43	do	do	From pile of unwashed ore from same pit as No. 635.	do	636	do
44	do	do	From pile of washed ore at furnace	Limonite ("yellow ore").	637	Sayers & Oglesby Furnace bank, Wythe county.
45	do	do	do	Limonite ("red ore")	638	do
46	do	do	From two test pits ½ mile south from Mr. Sampson's house.	Manganiferous limonite.	639	Sampson property, Cripple creek, Wythe county.
47	do	do	From manganiferous ore pits in woods	Limonite and manganiferous limonite.	640	Chadwell farm, near Brown Hill furnace, Wythe county.
48	do	do	From fragments near roadside	do	641	do
49	do	do	From pile of washed ore at furnace	Limonite	642	Noble bank, near Brown Hill furnace, Wythe county.
50	do	do	From new pit (10 to 12 feet deep)	do	628	Johnson bank, Little Red Island creek, Pulaski county.
51	do	do		do	629	Rich Hill bank, Little Red Island creek, Pulaski county.
52	do	do	From open cut	do	632	Panic Furnace property, Smyth county.
53	do	do	From excavation on hillside	do	633	do
54	do	do	From two open cuts on same bed	Siliceous hematite	643	Arcadia Furnace property, Stoney creek, Botetourt county.
55	do	do	From two open cuts ending in drifts on two beds about 150 yards apart.	do	644	do
56	do	do	From small piles of ore near furnace	Limonite	650	Arcadia Furnace bank, Jennings' creek, Botetourt county.
57	do	do	From outcrop of bed on roadside	Siliceous hematite	645	Wood's property, near Buchanan, Botetourt county.
58	do	do	From several old openings	Limonite	646	Retreat bank, Schultz property, Botetourt county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

VIRGINIA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.044	41.55	TiO_2 present; Mn. present	0.044	41.60	TiO_2 present; Mn. present	0.106	13
0.126	39.75	TiO_2 present	0.126	39.85	TiO_2 present	0.317	14
0.121	24.67		0.121	24.69		0.490	15
0.057	46.63		0.057	46.67		0.122	16
0.118	38.43	TiO_2 present	0.118	38.51	TiO_2 present	0.307	17
0.850	44.54	do	0.857	44.90	do	1.908	18
0.049	53.02		0.049	53.20		0.092	19
0.613	34.19	Mn. present	0.620	34.59	Mn. present	1.793	20
0.577	50.73		0.582	51.13		1.137	21
0.120	34.12		0.121	34.26		0.244	22
0.253	53.79		0.256	54.38		0.470	23
0.630	44.40	Mn. present	0.634	44.67	Mn. present	1.419	24
0.357	32.31		0.358	32.41		1.102	25
0.527	41.69	Mn. present	0.533	42.15	Mn. present	1.264	26
0.250	40.65	TiO_2 present	0.251	41.05	TiO_2 present	0.615	27
0.535	36.27	Mn. present; TiO_2 present	0.541	36.65	Mn. present; TiO_2 present	1.476	28
0.072	60.87	Mn. present	0.072	61.21	Mn. present	0.118	29
0.086	59.83	Mn. present; TiO_2 present	0.089	60.20	Mn. present; TiO_2 present	0.144	30
0.117	26.13	Mn. present	0.120	26.85	Mn. present	0.448	31
0.055	46.69	Mn. present; TiO_2 present	0.055	46.97	Mn. present; TiO_2 present	0.118	32
0.018	53.59	S 0.364 p. ct. Complete analysis	0.018	53.66	S 0.364 p. ct.	0.034	33
0.203	43.00	Mn. present	0.205	43.38	Mn. present	0.472	34
0.027	58.30		0.028	59.54		0.046	35
0.113	55.04		0.115	55.90		0.205	36
0.083	56.29	S 0.062 p. ct. Complete analysis	0.085	57.47	S 0.063 p. ct.	0.148	37
0.023	56.43		0.024	57.78		0.041	38
0.051	58.58	Mn. present	0.052	59.33	Mn. present	0.087	39
0.229	49.96	do	0.233	50.84	do	0.458	40
0.160	46.26	Mn. present; TiO_2 present	0.163	47.11	Mn. present; TiO_2 present	0.346	41
0.156	56.29	S 0.094 p. ct. Complete analysis	0.158	56.97	S 0.095 p. ct.	0.277	42
0.165	42.23	S 0.063 p. ct. Complete analysis	0.167	42.77	S 0.064 p. ct.	0.350	43
0.179	54.21	Mn. present	0.181	54.81	Mn. present	0.330	44
0.117	53.14	do	0.119	53.90	do	0.220	45
0.086	51.15	do	0.087	51.89	do	0.168	46
0.068	34.84		0.069	35.38		0.195	47
0.150	54.63		0.151	55.15		0.275	48
0.053	54.56		0.054	55.53		0.097	49
0.033	56.43		0.033	57.13		0.058	50
0.034	56.22		0.034	56.90		0.060	51
0.125	46.61	S 0.056 p. ct. Complete analysis	0.127	47.51	S 0.057 p. ct.	0.267	52
0.087	46.12	Mn. present; TiO_2 present	0.088	46.90	Mn. present; TiO_2 present	0.189	53
0.393	39.52		0.396	39.79		0.994	54
0.462	44.06		0.465	44.37		1.049	55
0.271	48.88	Mn. present; TiO_2 present	0.273	49.27	Mn. present; TiO_2 present	0.554	56
0.409	42.64		0.411	42.89		0.959	57
0.555	53.35	Mn. present	0.562	54.03	Mn. present	1.040	58

TABLE 25.—*Partial analyses of iron ores*—Continued.

VIRGINIA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
59	Gooch	Benton	From excavation in mountain side	Limonite	647	Carnes bank, Schultz property, Botetourt county.
60	do	do	From cross-cut showing ore at surface of deposit.	Manganiferous limonite.	648	Spengler bank, Schultz property, Botetourt county.
61	do	do	From small piles of ore near furnace	Limonite	649	Salisbury Furnace bank, Purgatory mountain, Botetourt county.
62	do	do	From excavation on hillside	do	651	May's bank, May's mountain, Botetourt county.
63	do	do	From old bank ¼ mile southwest from furnace	do	655	Callie Furnace bank (old), Botetourt county.
64	do	do	From 1,000 tons of ore at furnace	do	656	Callie Furnace bank (new), Botetourt county.
65	do	do	From piles of lump-ore from two cuts at present worked.	do	700	Hickory Hollow or Salisbury furnace, Botetourt county.
66	do	do	From piles of lump- and fine-ore average of mine.	do	1001	do
67	do	do	From four pits 4 miles northeast of furnace	do	652	Lucy Selina (Longdale) bank, Brushy mountain, Alleghany county.
68	do	do	From 10,000 tons lump ore at furnace	do	653	do
69	do	do	From pile of fine ore (ocherous) at furnace	do	654	do
70	do	do	From pile of ore at mine	Hematite (fossil)	657	Quinnimont mine at Clifton Forge, Alleghany county.
71	do	do	From five pits on northeast side of Fork run	Limonite	658	Lowmoor, Lowmoor station, Alleghany county.
72	do	do	From four tunnels on southwest side of Fork run.	do	659	do
73	do	do	From across 10-foot bed at head of tunnel	do	1002	Dickey, near Covington, Alleghany county.
74	do	do	From across 15 feet of upper surface of bed	do	1003	Smith or McAlister, Covington, Alleghany county.
75	do	do	From 50 tons lump ore ready for shipment	do	1004	Trice's bank, Peter's mountain, Alleghany county.
76	do	do	From across face of bed at end of main cut	do	1005	Sadler's, on Stack's land, near Covington, Alleghany county.
77	do	do	From 300 tons of lump ore ready for shipment	do	1006	do
78	do	do	From across face of bed, avoiding siliceous band.	do	1007	Gay & Lewis, Peter's mountain, Alleghany county.
79	do	do	From 25 tons of ore at bank ready for shipment	do	1008	Huddleston bank, Peter's mountain, Alleghany county.
80	do	do	From across 6 feet of outcrop, the best of the deposit.	do	1009	Potts Creek outcrops, A. Given's land, Alleghany county.
81	do	do	From across 12 feet of deposit about the middle of exposure.	do	1010	Dolly Ann furnace, Pounding Mill run, Alleghany county.
82	do	do	From 30 or 40 tons of screened ore at mine	do	1011	Wills', Covington, Alleghany county.
83	do	do	From open cut ½ mile north-northeast from furnace.	do	660	Buffalo Gap furnace, Augusta county.
84	do	do	From open cut ¾ mile southeast from furnace	Limonite and earthy hematite.	661	Ferrol (Elizabeth furnace), Augusta county.
85	do	do	From variety of "hematite" in same pit	do	662	do
86	do	do	From pit ¼ mile west from furnace	Limonite	663	Kennedy Furnace bank, Augusta county
87	do	do	do	do	664	Mount Torrey Furnace bank, Augusta county
88	do	do	From pit ½ mile southwest from furnace No. 2	do	665	Fox Mountain bank, Rockingham county.
89	do	do	From large pile of washed fine ore at washer	do	666	do
90	do	do	From pile of washed and roasted fine ore at kiln.	Limonite (roasted)	667	do
91	do	do	From pile of unwashed roasted ore at furnace	Limonite	668	do
92	do	do	From five tons of ore at mine	do	673	Miller bank, near Mount Vernon furnace, Rockingham county.
93	do	do	From stock pile at furnace	Limonite and hematite.	674	Raines & Weaver banks, Mount Vernon furnace, Rockingham county.
94	do	do	From piles of ore at washer 4 miles north-northeast from furnace.	do	675	do
95	do	do	From heading of tunnel in west bank 1½ miles southwest from furnace.	Limonite	669	West bank, near Van Buren furnace, Shenandoah county.
96	do	do	From stock piles at furnace	do	670	Three Top Mountain bank, near Mine Run Furnace, Shenandoah county.
97	do	do	From pit ½ mile north from furnace	Limonite and hematite.	671	Old bank, near Liberty Furnace, Shenandoah county.
98	do	do	From most northerly and from middle shaft ½ mile north-northeast from furnace.	do	672	Hollow bank, Liberty Furnace, Shenandoah county.
99	do	do	From piles of ore at mine	Limonite	699	Stonewall, near Stonewall creek, Appomattox county.
100	do	do	From 250 tons of ore at mine ready for shipment.	Specular	1021	Chestnut mountain, Chestnut mountain, Appomattox county.

WASHINGTON.

1	Whitfield	Putnam	From 300 tons of ore at Puget Sound Iron Company's furnace, Irondale.	Bog	1168	Puget Sound Iron Company, Chimicon valley, Jefferson county.

WEST VIRGINIA.

1	Whitfield	Benton	From 1-foot seam of ore in pit, 8 to 10 feet below surface.	Carbonate, "Martin's ore".	690	Johnson mine, Monongalia county
2	do	do	From piles of ore at mouth of drift	Carbonate and limonite, "England ore".	691	do
3	do	do	From piles of fresh ore at mouth of drift	Carbonate, "Spring Hill ore".	692	Spring Hill, or Wadsworth bank, Monongalia county.
4	do	do	From 1 lump of ore near old mine	Carbonate, "Haine's ore".	693	Near Laurel Iron Works, Cole's Run, Monongalia county.

TABLE 25.—*Partial analyses of iron ores*—Continued.

VIRGINIA—Continued.

NATURAL ORE.			DRIED ORE.			P. ratio.	
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.		
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.376	52.01		0.379	52.39		0.723	59
0.031	29.59	Mn. present; TiO_2 present	0.031	29.92	Mn. present; TiO_2 present	0.105	60
0.111	50.94	do do	0.112	51.36	do do	0.218	61
0.045	56.19	do do	0.045	56.52	do do	0.080	62
0.067	45.62	TiO_2 present	0.068	46.17	TiO_2 present	0.147	63
0.095	25.26	Mn. present; TiO_2 present	0.096	25.57	Mn. present; TiO_2 present	0.376	64
0.287	40.17	do do	0.291	40.74	do do	0.714	65
0.273	38.64	do do			do do	0.706	66
0.463	51.66	S 0.104 p. ct. Complete analysis	0.467	52.14	S 0.105 p. ct	0.896	67
0.224	51.70	Mn. present; TiO_2 present	0.225	52.06	Mn. present; TiO_2 present	0.433	68
0.290	47.47	do do	0.292	47.84	do do	0.611	69
0.444	41.71	do do	0.452	42.45	do do	1.064	70
0.636	43.84	S 0.007 p. ct. Complete analysis	0.642	44.25	S 0.007 p. ct	1.451	71
0.761	42.70	S 0.007 p. ct. Complete analysis	0.772	43.33	do	1.782	72
0.216	45.24	Mn. present; TiO_2 present	0.217	45.48	Mn. present; TiO_2 present	0.477	73
1.189	51.01		1.196	51.34		2.331	74
0.525	32.24	TiO_2 present	0.531	32.64	TiO_2 present	1.628	75
0.462	43.71	Mn. present	0.467	44.16	Mn. present	1.057	76
0.380	43.71	Mn. present; TiO_2 present	0.383	44.05	Mn. present; TiO_2 present	0.869	77
0.436	39.96	do do	0.439	40.25	do do	1.091	78
0.252	46.49	do do	0.254	46.88	do do	0.542	79
0.164	31.97		0.165	32.12		0.513	80
0.428	51.77	TiO_2 present	0.433	52.37	TiO_2 present	0.827	81
0.395	37.39	Mn. present; TiO_2 present	0.399	37.79	Mn. present; TiO_2 present	1.056	82
0.310	41.51	do do	0.313	41.95	do do	0.747	83
0.289	46.19	do do	0.293	46.76	do do	0.626	84
0.246	29.87	TiO_2 present	0.248	30.15	TiO_2 present	0.824	85
0.229	52.50	Mn. present	0.231	52.92	Mn. present	0.436	86
0.206	45.34		0.208	45.84		0.454	87
0.215	41.17	S 0.010 p. ct. Complete analysis	0.218	41.71	S 0.010 p. ct	0.523	88
0.166	46.29	Mn. present; TiO_2 present	0.169	47.09	Mn. present; TiO_2 present	0.359	89
0.078	43.96	do do	0.080	44.90	do do	0.177	90
0.224	49.25	do do	0.227	49.99	do do	0.455	91
0.274	45.41	do do	0.276	45.80	do do	0.603	92
0.103	51.30	S. 0.004 p. ct. Complete analysis	0.104	51.65	S 0.004 p. ct	0.201	93
0.231	41.15	Mn. present; TiO_2 present	0.233	41.49	Mn. present; TiO_2 present	0.561	94
0.066	35.26	do do	0.067	35.78	do do	0.187	95
0.153	43.78	do do	0.158	45.38	do do	0.349	96
0.114	41.71	TiO_2 present	0.115	42.20	TiO_2 present	0.273	97
0.076	43.90	Mn. present; TiO_2 present	0.077	44.38	Mn. present; TiO_2 present	0.173	98
0.478	42.81	do do	0.479	42.88	do do	1.116	99
0.012	42.94	Mn. present	0.012	43.00	Mn. present	0.028	100

WASHINGTON.

0.751	41.83		0.837	46.63		1.795	1

WEST VIRGINIA.

0.114	35.55		0.114	35.61		0.321	1
0.158	28.72		0.159	28.85		0.550	2
0.159	30.35		0.159	30.39		0.524	3
0.148	32.14		0.148	32.20		0.460	4

TABLE 25.—*Partial analyses of iron ores*—Continued.

WEST VIRGINIA—Continued.

	Chemist.	Sampler.	Remarks.	Kind of ore.	Number.	Name and location of mine.
5	Whitfield	Benton	From seam of ore in drift 50 feet from surface	Carbonate, "Big Honeycomb".	694	Hope mine, Monongalia county
6	do	do	From 1 lump of ore near old workings	Carbonate, "Stratford ore".	695	Cole's Run, Monongalia county
7	do	do	From 3 or 4 lumps of ore at old workings	Carbonate, "Hastings ore".	696	Near Ice's ferry, Monongalia county
8	do	do	Across breast of ore 12 feet thick, avoiding streaks of interbedded clay.	Limonite	1077	Bloomery furnace, Capon mountain, Hampshire county.
9	do	do	From 500 tons of ore at furnace	Fossil	1078	N. E. of Bloomery furnace, Capon mountain, Hampshire county.
10	do	do	From 100 tons of ore at furnace	do	1079	S. W. of Bloomery furnace, Capon mountain, Hampshire county.
11	do	do	Across 8 feet of the deposit, from top to bottom of the pit.	Hematite	1080	Olcar, near Keyser, Mineral county
12	do	do	From scattered surface fragments	Limonite	1081	Chris. Martin's land, near Ridgeville, Mineral county.
13	do	do	Across 2 beds of ore; aggregate thickness, 20 inches.	Fossil	1082	Lewis, Greenland gap, Grant county
14	do	do	Across 3 beds of ore; aggregate thickness, 6 feet.	do	1083	Outcrop on Wm. Michael's land, Walker's ridge, Grant county.
15	do	do	From 25 tons of ore at mine ready for furnace	Limonite	1084	Half Moon, Capon Iron Works, Hardy county.

WISCONSIN.

1	King	Willis	From pile of ore from outcrop	Specular	985	Old iron works, Black River Falls, Jackson county.
2	do	do	From outcrop of ore on summit of mound	Specular schist	986	Big iron mound, Black River Falls, Jackson county.
3	do	do	From outcrop	Hematite	987	Paddy's Rest creek, Sec. 17, T. 22, R. 3 W., Jackson county.
4	do	do	From lower part of bed	Fossil	988	Northwestern Iron Company, Iron mountain, Dodge county.
5	do	do	From upper part of stratum	do	989	do
6	do	do	From outcrop	do	990	Rock ore, Wisconsin Iron Company, Iron mountain, Dodge county.

WYOMING TERRITORY.

1	King	Putnam	At breast in cut	Hematite	1133	Shaw, near Rawlin's station, Carbon county.
2	do	do	do	do	1134	Friend, near Rawlin's station, Carbon county.

BRITISH COLUMBIA.

1	Whitfield	Putnam	From 600 tons of ore at Puget Sound Iron Company's furnace, Irondale, Washington territory.	Magnetite	1169	Puget Sound Iron Company, Texada island.

TABLE 25.—*Partial analyses of iron ores*—Continued.

WEST VIRGINIA—Continued.

NATURAL ORE.			DRIED ORE.				
P.	Fe.	Miscellaneous.	P.	Fe.	Miscellaneous.	P. calc.	
P. cent.	*P. cent.*		*P. cent.*	*P. cent.*		*P. cent.*	
0.271	30.90		0.272	30.97		0.677	5
0.154	29.89		0.154	29.95		0.515	6
0.780	31.13		0.781	31.22		2.506	7
0.086	38.04		0.087	38.40		0.226	8
0.286	49.53		0.294	50.94		0.577	9
0.996	47.05	TiO_2 present	1.011	47.78	TiO_2 present	2.117	10
0.218	29.65		0.219	29.78		0.735	11
0.708	56.36		0.715	56.89		1.256	12
0.554	43.09		0.559	43.50		1.286	13
0.487	47.36		0.487	47.36		1.028	14
0.361	43.55		0.365	44.04		0.829	15

WISCONSIN.*

0.057	35.45		0.057	35.49		0.161	1
0.047	37.09	TiO_2 absent	0.047	37.17	TiO_2 absent	0.127	2
0.104	19.36		0.105	19.58		0.537	3
1.118	36.06		1.125	36.27		0.310	4
1.392	51.75		1.403	52.17		2.690	5
0.534	56.52		0.536	56.68		0.945	6

*See also under Lake Superior.

WYOMING TERRITORY.

0.046	56.96		0.046	57.19		0.081	1
0.593	63.29		0.597	63.69		0.937	2

BRITISH COLUMBIA.

0.013	65.53		0.013	65.71		0.020	1

TABLE 26.—COMPLETE ANALYSES OF IRON ORES.

TABLE 26.—*Complete analyses of iron ores.*

		202		230		235		242	
		State: ALABAMA. *County:* Jefferson. *Location:* Eureka mine, Sec. 21, T. 18, R. 3 W. *Analysis No.:* 202. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Fossil. *Remarks:* From face of ore near end of entry, seam No. 1.		*State:* ALABAMA. *County:* Tuscaloosa. *Location:* Eureka mine, Sec. 2, T. 21, R. 6 W. *Analysis No.:* 230. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From lumps in place in lower bed S. by W. of washing machine.		*State:* ALABAMA. *County:* Shelby. *Location:* Shelby mine, Sec. 13, T. 22, R. 1 W. *Analysis No.:* 235. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From washed ore at washer.		*State:* ALABAMA. *County:* Talladega. *Location:* Clifton bank, Sec. 26, T. 18, R. 6 E. *Analysis No.:* 242. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From two pits 100 yards apart on bed No. 6.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity			3.458		3.725		3.732	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.139	0.140	0.318	0.320	0.139	0.140	0.109	0.110
2	Phosphorus	0.219	0.220	0.179	0.181	0.241	0.243	0.041	0.041
3	Iron, metallic	51.25	51.60	46.59	47.00	52.82	53.26	52.22	52.51
1	Silica	16.59	16.70	15.07	15.20	6.62	6.68	9.42	9.47
2	Iron, protoxide	0.19	0.19	0.26	0.26	0.34	0.34	0.19	0.19
3	Iron, peroxide	72.84	73.33	65.89	66.46	74.88	75.54	74.81	74.73
4	Alumina	6.57	6.62	5.41	5.46	3.30	3.32	1.80	1.81
5	Manganese, protoxide	0.37	0.37	0.72	0.72	1.41	1.43	1.00	1.01
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	0.27	0.27	0.65	0.65	0.82	0.83	0.34	0.34
9	Magnesia	0.22	0.22	0.25	0.25	1.02	1.02	0.23	0.23
10	Iron, disulphide	0.26	0.262	0.595	0.600	0.260	0.262	0.119	0.120
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide							0.14	0.14
16	Nickel, oxide								
17	Cobalt, sulphide							Trace.	Trace.
18	Cobalt, oxide								
19	Copper, sulphide							Trace.	Trace.
20	Lead								
21	Antimony, sulphide								
22	Potassa								
23	Soda								
24	Carbonic acid	0.07	0.07	0.57	0.57	0.25	0.25	0.34	0.34
25	Sulphuric acid								
26	Phosphoric acid	0.501	0.504	0.410	0.414	0.551	0.556	0.934	0.939
27	Titanic acid								
28	Carbon in carbonaceous matter	0.02	0.02	0.20	0.20	0.09	0.09	0.26	0.26
29	Hygroscopic water	0.65		0.84		0.87		0.55	
30	Water of composition	1.52	1.53	9.23	9.30	9.62	9.70	10.55	10.60
	Total	100.071	100.086	100.095	100.084	100.031	100.018	100.183	100.179
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	19.28	19.41	18.04	18.20	7.89	7.96	11.09	11.17
1	Silica	16.50	16.70	15.07	15.20	6.62	6.68	9.42	9.47
2	Alumina	2.52	2.54	2.89	2.92	1.17	1.18	1.50	1.51
3	Iron, protoxide								
4	Lime	0.12	0.12	0.10	0.10	0.08	0.08	0.07	0.07
5	Magnesia	0.07	0.07	0.04	0.04	0.04	0.04	0.12	0.12
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa								
10	Soda								
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium sesquioxide								
	Total	19.30	19.43	18.10	18.26	7.91	7.98	11.11	11.17

TABLE 26.—*Complete analyses of iron ores.*

252		267		783		433		439		472		
State: ALABAMA. *County:* Cherokee. *Location:* Tecumseh Iron Co., Sec. 18, T. 12, R. 12 E. *Analysis No.:* 252. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From wagons direct from bank.		*State:* ALABAMA. *County:* Etowah. *Location:* Attala, Sec. 34, T. 11, R. 5 E. *Analysis No.:* 267. *Sampler:* Chauvenet. *Chemist:* King. *Kind of ore:* Fossil. *Remarks:* From tunneled ore at mine.		*State:* CONNECTICUT. *County:* Litchfield. *Location:* Brookpit (Old Hill), Salisbury. *Analysis No.:* 783. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Limonite. *Remarks:* From five cars of rock ore at mine.		*State:* GEORGIA. *County:* Bartow. *Location:* Wildcat bank, near Cartersville. *Analysis No.:* 433. *Sampler:* Willis. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From pile of ore at Dismond furnace.		*State:* GEORGIA. *County:* Bartow. *Location:* Mumford bank, Cartersville. *Analysis No.:* 439. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From bank.		*State:* GEORGIA. *County:* Bartow. *Location:* Gray ore bank, Etowah river. *Analysis No.:* 472. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Specular. *Remarks:* From vein in new opening.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
3.706	.....	4.110	.....	.....	.....	3.634	.....	3.863	.....	4.445	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.179	0.180	0.085	0.086	0.150	0.151	0.179	0.180	0.008	0.008	0.006	0.006	1
0.108	0.108	0.641	0.648	0.196	0.198	0.668	0.672	0.330	0.331	0.010	0.010	2
50.04	50.25	53.60	54.15	50.12	50.53	50.64	50.96	55.69	55.87	57.00	57.00	3
11.23	11.28	10.52	10.63	9.84	9.92	8.94	9.00	4.49	4.50	16.67	16.67	1
0.22	0.22	0.46	0.46	0.25	0.25	0.34	0.34	0.48	0.48	0.44	0.44	2
71.15	71.45	75.99	76.77	69.46	70.03	71.82	72.28	79.01	79.27	80.95	80.95	3
4.09	5.01	5.58	5.64	3.65	3.68	4.24	4.27	4.73	4.75	1.34	1.34	4
.....	.....	0.23	0.23	1.27	1.28	0.42	0.42	Trace.	Trace.	Trace.	Trace.	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.25	0.25	2.23	2.25	1.12	1.13	1.08	1.09	0.17	0.17	0.09	0.09	8
0.25	0.25	0.52	0.52	0.86	0.87	0.63	0.63	0.21	0.21	0.11	0.11	9
0.337	0.338	0.124	0.125	0.279	0.281	0.335	0.337	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.14	0.14	0.17	0.17	0.69	0.70	.....	.....	.....	.....	.....	.....	22
0.11	0.11	0.01	0.01	0.44	0.44	.....	.....	.....	.....	.....	.....	23
0.13	0.13	0.09	0.09	0.14	0.14	0.40	0.40	0.09	0.09	0.09	0.09	24
.....	.....	0.05	0.05	0.04	0.04	.....	.....	0.02	0.02	0.02	0.02	25
0.246	0.247	1.469	1.484	0.450	0.454	1.528	1.538	0.756	0.758	0.024	0.024	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
0.25	0.25	0.04	0.04	0.06	0.06	0.01	0.01	0.08	0.08	0.01	0.01	28
0.42	.....	1.02	.....	0.81	.....	0.63	.....	0.33	.....	.....	.....	29
10.20	10.24	1.69	1.71	10.67	10.75	9.69	9.75	9.69	9.72	0.31	0.31	30
99.923	99.915	100.193	100.179	100.029	100.025	100.063	100.065	100.056	100.048	100.054	100.054	
15.14	15.20	13.31	13.44	12.69	12.79	11.67	11.74	6.95	6.97	17.55	17.55	
11.23	11.28	10.52	10.63	9.84	9.92	8.94	9.00	4.49	4.50	16.67	16.67	1
3.30*	3.31*	2.35	2.37	2.01*	2.03*	2.29	2.30	2.17	2.18	0.81	0.81	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
0.15	0.15	0.05	0.05	0.14	0.14	0.19	0.19	0.04	0.04	0.01	0.01	4
0.16	0.16	0.20	0.20	0.29	0.29	0.27	0.27	0.21	0.21	0.05	0.05	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.14	0.14	0.17	0.17	0.41	0.41	.....	.....	.....	.....	.....	.....	9
0.11	0.11	0.01	0.01	.....	.....	.....	.....	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
15.09	15.15	13.30	13.43	12.69	12.79	11.69	11.76	6.91	6.93	17.54	17.54	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		474		814		677		1	
		State: GEORGIA. *County:* Walker. (?) *Location:* Snake Creek bank, Snake Creek gap. *Analysis No.:* 474. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From exposure of ore in old pit.		*State:* KENTUCKY. *County:* Lawrence. *Location:* Shepherd bank, Hunnewell furnace. *Analysis No.:* 814. *Sampler:* Chauvenet. *Chemist:* King. *Kind of ore:* Carbonate. *Remarks:* From "red-lime" ore in bank.		*State:* MAINE. *County:* Piscataquis. *Location:* Katahdin iron works. *Analysis No.:* 677. *Sampler:* Benton. *Chemist:* Richmond. *Kind of ore:* Limonite. *Remarks:* From pile of raw ore at furnace and from three excavations one mile west of furnace.		*State:* MICHIGAN. *County:* Marquette. *Location:* Michigamme mine. *Analysis No.:* 1. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From stope, pit No. 4, fourth level, 130 feet east of shaft.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity	3.662							
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.258	0.261	0.227	0.227	3.004	3.127	0.103	0.103
2	Phosphorus	1.359	1.372	0.126	0.128	0.009	0.009	0.095	0.095
3	Iron, metallic	51.41	51.98	40.61	40.85	46.00	47.88	63.55	63.58
1	Silica	5.99	6.06	14.37	14.59	8.50	8.85	5.24	5.24
2	Iron, protoxide	0.38	0.38	4.93	5.01	3.32	3.45	28.52	28.53
3	Iron, peroxide	72.98	73.78	53.93	54.75	59.95	62.30	58.99	59.01
4	Alumina	5.36	5.42	9.36	9.50	2.08	2.16	2.95	2.95
5	Manganese, protoxide	Trace.	Trace.	1.26	1.28	0.02	0.02	0.34	0.34
6	Manganese, dioxide								
7	Chromium, sesquioxide					0.19	0.20		
8	Lime			1.03	1.05	1.50	1.56	0.94	0.94
9	Magnesia	0.24	0.24	0.52	0.53	1.96	2.04	0.78	0.78
10	Iron, disulphide	0.071	0.071	0.072	0.073	3.270	3.400	0.193	0.193
11	Iron, arsenide								
12	Zinc, sulphide	0.21	0.21						
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide			0.25	0.25	0.13	0.14		
16	Nickel, oxide								
17	Cobalt, sulphide			0.21	0.21				
18	Cobalt, oxide								
19	Copper, sulphide			0.03	0.03	0.06	0.06		
20	Lead								
21	Antimony, sulphide								
22	Potassa					0.12	0.12		
23	Soda					0.28	0.29		
24	Carbonic acid	0.11	0.11	3.66	3.72	0.08	0.08	1.10	1.10
25	Sulphuric acid			0.02	0.02	3.05	3.17		
26	Phosphoric acid	3.106	3.140	0.290	0.294	0.020	0.021	0.217	0.217
27	Titanic acid								
28	Carbon in carbonaceous matter	0.06	0.06	0.15	0.15	0.27	0.28	0.05	0.05
29	Hygroscopic water	1.09		1.49		3.86		0.04	
30	Water of composition	10.49	10.60	8.54	8.66	11.46	11.87	0.72	0.72
	Total	100.087	100.071	100.112	100.117	100.120	100.011	100.080	100.070
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	7.20	7.28	19.43	19.73	12.69	13.17	6.24	6.24
1	Silica	5.99	6.06	14.37	14.59	8.50	8.85	5.24	5.24
2	Alumina	1.14	1.15	4.98	5.06	2.15	2.20	0.80	0.80
3	Iron, protoxide								
4	Lime					0.58	0.60		
5	Magnesia	0.07	0.07	0.07	0.07	1.51	1.57	0.19	0.19
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa								
10	Soda								
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	7.20	7.28	19.42	19.72	12.74	13.22	6.23	6.23

TABLE 26.—*Complete analyses of iron ores*—Continued.

4		5		7		10		16		17		
State: MICHIGAN. *County:* Marquette. *Location:* Michigamme mine. *Analysis No.:* 4. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From winze 100 feet west of shaft No. 1, 35 feet below surface.		*State:* MICHIGAN. *County:* Marquette. *Location:* Republic mine. *Analysis No.:* 5. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Specular. *Remarks:* From pillar in pit No. 5, fourth level, 70 ft. south from shaft, from foot-wall to schist "horse."		*State:* MICHIGAN. *County:* Marquette. *Location:* Republic mine. *Analysis No.:* 7. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Magnetite. *Remarks:* From same pillar as sample No. 5, from schist "horse" to hanging-wall.		*State:* MICHIGAN. *County:* Marquette. *Location:* Boston mine. *Analysis No.:* 10. *Sampler:* Fay. *Chemist:* Gooch. *Kind of ore:* Specular. *Remarks:* Average of output.		*State:* MICHIGAN. *County:* Menominee. *Location:* Quinnesec mine. *Analysis No.:* 16. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From stope, pit No. 2, third level.		*State:* MICHIGAN. *County:* Menominee. *Location:* Quinnesec mine. *Analysis No.:* 17. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From stope, pit No. 2, near hanging-wall; ore with greenish mineral.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
4.865	.....	5.113	.....	5.071	.....	.....	.....	4.204	.....	4.146	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.027	0.027	0.037	0.037	0.050	0.050	0.007	0.007	0.050	0.050	0.059	0.059	1
0.053	0.053	0.024	0.024	0.051	0.051	0.009	0.009	0.010	0.010	0.009	0.009	2
65.24	65.25	67.02	67.02	69.62	69.69	66.36	66.37	61.81	61.93	55.49	55.58	3
5.78	5.78	3.38	3.38	1.41	1.41	2.61	2.61	7.37	7.38	9.29	9.31	1
29.94	29.94	1.05	1.05	20.87	20.89	1.26	1.26	1.97	1.97	2.87	2.87	2
59.89	59.91	94.58	94.58	76.27	76.35	93.30	93.41	86.05	86.22	76.02	76.14	3
2.20	2.20	0.38	0.38	0.52	0.52	1.59	1.59	1.81	1.81	4.68	4.69	4
0.16	0.16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.27	0.27	0.03	0.03	0.13	0.13	0.04	0.04	0.41	0.41	0.27	0.27	8
0.63	0.63	0.33	0.33	0.25	0.25	.....	.....	0.84	0.84	3.54	3.55	9
0.051	0.051	0.067	0.067	0.094	0.094	0.013	0.013	0.090	0.090	0.110	0.110	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	.....	0.31	0.31	0.55	0.55	0.99	0.99	22
.....	.....	.....	.....	.....	.....	0.07	0.07	.....	.....	0.02	0.02	23
0.17	0.17	0.08	0.08	0.05	0.05	0.08	0.08	0.19	0.19	0.30	0.30	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
0.121	0.121	0.055	0.055	0.117	0.117	0.022	0.022	0.024	0.024	0.021	0.021	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
.....	.....	.....	.....	0.01	0.01	.....	.....	.....	.....	.....	.....	28
0.02	.....	.....	.....	0.10	.....	0.02	.....	0.20	.....	0.16	.....	29
0.88	0.88	0.14	0.14	0.20	0.20	0.65	0.65	0.50	0.50	1.72	1.72	30
100.112	100.112	100.092	100.092	100.021	100.021	100.055	100.055	100.004	99.984	99.991	99.991	
6.11	6.11	3.59	3.59	1.79	1.79	4.88	4.88	8.94	8.96	12.00	12.02	
5.78	5.78	3.38	3.38	1.41	1.41	2.61	2.61	7.37	7.38	9.29	9.31	1
0.34	0.34	0.21*	0.21*	0.40*	0.40*	1.84	1.84	0.93	0.93	1.61	1.61	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	0.04	0.04	0.14	0.14	0.09	0.09	4
.....	.....	.....	.....	.....	.....	.....	.....	0.05	0.05	0.09	0.09	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	0.31	0.31	0.46	0.46	0.93	0.93	9
.....	.....	.....	.....	.....	.....	0.07	0.07	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
6.12	6.12	3.59	3.59	1.81	1.81	4.87	4.87	8.95	8.96	12.01	12.03	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		18		19		20		22	
		State: MICHIGAN. *County:* Menominee. *Location:* Quinnesec mine. *Analysis No.:* 18. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From stope, pit No. 1, third level.		*State:* MICHIGAN. *County:* Menominee. *Location:* Quinnesec mine. *Analysis No.:* 19. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* Selected clippings of "hard ore" in pit No. 1.		*State:* MICHIGAN. *County:* Menominee. *Location:* Quinnesec mine. *Analysis No.:* 20. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From stope, pit No. 3, third level.		*State:* MICHIGAN. *County:* Menominee. *Location:* Cornell mine. *Analysis No.:* 22. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Hematite. *Remarks:* A cross vein of "red ore" exposed in stripping.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity	4.701		4.882		4.518		4.694	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.086	0.086	0.050	0.050	0.053	0.053	0.059	0.059
2	Phosphorus	0.012	0.012	0.005	0.005	0.009	0.009	0.043	0.043
3	Iron, metallic	66.39	66.40	64.47	64.47	65.60	65.63	58.06	58.12
1	Silica	2.58	2.58	6.99	6.99	3.03	3.03	9.04	9.05
2	Iron, protoxide	1.81	1.81	2.36	2.36	1.97	1.97	1.10	1.10
3	Iron, peroxide	92.73	92.74	89.41	89.41	91.47	91.51	81.64	81.73
4	Alumina	0.86	0.86	0.35	0.35	1.53	1.53	3.83	3.83
5	Manganese, protoxide	Trace.	Trace.	Trace.	Trace.				
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	0.50	0.50	0.29	0.29	0.36	0.36	0.19	0.19
9	Magnesia	0.31	0.31	0.13	0.13	0.21	0.21	0.86	0.86
10	Iron, disulphide	0.161	0.161	0.093	0.093	0.099	0.099	0.111	0.111
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide								
16	Nickel, oxide								
17	Cobalt, sulphide								
18	Cobalt, oxide								
19	Copper, sulphide								
20	Lead								
21	Antimony, sulphide								
22	Potassa	0.37	0.37	0.05	0.05	0.57	0.57	1.54	1.54
23	Soda			0.03	0.03	0.03	0.03	0.17	0.17
24	Carbonic acid	0.38	0.38	0.24	0.24	0.38	0.38	0.18	0.18
25	Sulphuric acid								
26	Phosphoric acid	0.027	0.027	0.013	0.013	0.021	0.021	0.09	0.09
27	Titanic acid								
28	Carbon in carbonaceous matter								
29	Hygroscopic water	0.01				0.04		0.11	
30	Water of composition	0.30	0.30	0.01	0.01	0.27	0.27	1.13	1.13
	Total	100.038	100.038	99.966	99.966	99.980	99.980	99.998	99.988
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	3.65	3.65	7.40	7.40	4.61	4.61	13.61	13.62
1	Silica	2.58	2.58	6.99	6.99	3.03	3.03	9.04	9.05
2	Alumina	0.70	0.70	0.25	0.25	0.93	0.93	2.77	2.77
3	Iron, protoxide								
4	Lime	0.01	0.01	0.02	0.02	0.07	0.07	0.01	0.01
5	Magnesia	0.12	0.12	0.05	0.05	0.06	0.06	0.26	0.26
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa	0.30	0.30	0.05	0.05	0.51	0.51	1.44	1.44
10	Soda			0.03	0.03	0.03	0.03	0.11	0.11
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	3.71	3.71	7.39	7.39	4.63	4.63	13.63	13.64

TABLE 26.—*Complete analyses of iron ores*—Continued.

23		25		26		31		37		40		
State: MICHIGAN. *County:* Menominee. *Location:* Cornell mine. *Analysis No.:* 23. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* Across vein of "blue ore" exposed in stripping.		*State:* MICHIGAN. *County:* Menominee. *Location:* Chapin mine. *Analysis No.:* 25. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Hematite. *Remarks:* From near foot-wall at bottom of shaft No. 2.		*State:* MICHIGAN. *County:* Menominee. *Location:* Chapin mine. *Analysis No.:* 26. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Soft specular. *Remarks:* From 900 tons of ore from shaft No. 3.		*State:* MICHIGAN. *County:* Menominee. *Location:* Norway mine. *Analysis No.:* 31. *Sampler:* Putnam. *Chemist:* Pitman. *Kind of ore:* Specular. *Remarks:* Fragments from line of test pits extending west from top of new incline.		*State:* MICHIGAN. *County:* Menominee. *Location:* Norway mine. *Analysis No.:* 37. *Sampler:* Putnam. *Chemist:* Pitman. *Kind of ore:* Hematite. *Remarks:* From stope and broken ore in pit No. 6; ore with yellowish-green mineral.		*State:* MICHIGAN. *County:* Menominee. *Location:* Norway mine. *Analysis No.:* 40. *Sampler:* Putnam. *Chemist:* Pitman. *Kind of ore:* Hematite. *Remarks:* From 75 tons of ore from pit No. 2.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
.....	.....	4.534	.....	4.404	.....	.....	.....	4.894	.....	3.926	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.078	0.078	0.018	0.018	0.001	0.001	0.043	0.043	0.058	0.058	0.058	0.058	1
0.032	0.032	0.011	0.011	0.007	0.007	0.047	0.047	0.084	0.084	.....	.....	2
56.99	57.03	62.65	62.77	65.97	66.02	60.20	60.20	62.73	62.90	51.09	51.14	3
10.71	10.72	4.42	4.43	3.23	3.23	12.43	12.43	3.42	3.43	11.88	11.89	1
1.10	1.10	1.81	1.81	0.81	0.81	0.68	0.68	0.82	0.82	3.77	3.77	2
80.09	80.15	87.47	87.64	93.34	93.41	85.19	85.19	88.77	89.01	68.74	68.80	3
3.88	3.88	2.37	2.37	1.03	1.03	0.02	0.02	2.37	2.38	5.49	5.49	4
.....	.....	0.25	0.25	0.03	0.03	.....	.....	.....	.....	0.03	0.03	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.17	0.17	0.26	0.26	0.06	0.06	0.68	0.68	1.10	1.10	0.93	0.93	8
0.48	0.48	1.58	1.58	0.45	0.45	0.21	0.21	1.44	1.44	5.55	5.56	9
0.146	0.146	0.034	0.034	0.002	0.002	0.080	0.080	0.109	0.109	0.109	0.109	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
2.29	2.29	0.38	0.38	0.53	0.53	.....	.....	.....	.....	.....	.....	22
0.30	0.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
0.08	0.08	0.12	0.12	0.11	0.11	0.40	0.40	0.50	0.50	0.13	0.13	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
0.074	0.074	0.026	0.026	0.017	0.017	0.108	0.108	0.192	0.192	.....	.....	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
.....	.....	0.01	0.01	.....	.....	0.006	0.006	0.006	0.006	.....	.....	28
0.07	.....	0.19	.....	0.07	.....	.....	.....	0.27	.....	0.09	.....	29
0.56	0.56	1.12	1.12	0.39	0.39	0.284	0.284	1.21	1.21	3.52	3.52	30
99.950	99.950	100.040	100.030	100.069	100.069	100.088	100.088	100.207	100.197	100.239	100.229	
16.44	16.45	5.28	5.29	4.82	4.82	12.78	12.78	3.70	3.71	12.39	12.40	
10.71	10.72	4.42	4.43	3.23	3.23	12.43	12.43	3.42	3.43	11.88	11.89	1
3.21	3.21	0.64	0.64	1.06	1.06	0.26*	0.26*	0.12*	0.12*	0.31*	0.31*	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	0.01	0.01	0.02	0.02	0.07	0.07	0.26	0.26	0.19	0.19	4
0.08	0.08	0.03	0.03	0.05	0.05	0.03	0.03	0.02	0.02	0.04	0.04	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
2.23	2.23	0.20	0.20	0.50	0.50	.....	.....	.....	.....	.....	.....	9
0.20	0.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
16.43	16.44	5.30	5.31	4.86	4.86	12.79	12.79	3.82	3.83	12.42	12.43	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		46		60		65		68	
		State: MICHIGAN. *County:* Menominee. *Location:* Stephenson mine. *Analysis No.:* 46. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Specular. *Remarks:* From 75 tons of ore from shaft near property line.		*State:* MICHIGAN. *County:* Menominee. *Location:* Vulcan mine. *Analysis No.:* 60. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From stope in E. shaft, pit No. 3, 59 feet below the surface.		*State:* MICHIGAN. *County:* Menominee. *Location:* Vulcan mine. *Analysis No.:* 65. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Soft specular. *Remarks:* From old stope in pit No. 1.		*State:* MICHIGAN. *County:* Menominee. *Location:* McKenna mine, N. E. of S. E. Sec. 32, T. 40, R. 30. *Analysis No.:* 68. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Soft specular. *Remarks:* From 750 tons of ore from shaft.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity	4.621		5.036		4.371		4.187	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.004	0.004	0.050	0.050	0.023	0.023		
2	Phosphorus	0.069	0.069	0.001	0.001	0.001	0.001	0.061	0.061
3	Iron, metallic	52.78	52.80	67.62	67.62	62.89	62.95	54.39	54.51
1	Silica	13.85	13.83	1.23	1.23	6.23	6.24	3.94	3.95
2	Iron, protoxide	2.97	2.97	1.19	1.19	1.06	1.06	1.36	1.36
3	Iron, peroxide	72.06	72.09	95.22	95.22	88.62	88.71	76.18	76.36
4	Alumina	3.39	3.39	0.74	0.74	1.98	1.98	1.18	1.18
5	Manganese, protoxide	0.11	0.11			0.02	0.02	0.17	0.17
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	0.33	0.33	0.21	0.21	0.13	0.13	4.87	4.88
9	Magnesia	4.29	4.29	0.50	0.50	0.61	0.61	3.60	3.61
10	Iron, disulphide	0.007	0.007	0.093	0.093	0.043	0.043		
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide								
16	Nickel, oxide								
17	Cobalt, sulphide								
18	Cobalt, oxide								
19	Copper, sulphide								
20	Lead								
21	Antimony, sulphide								
22	Potassa			0.06	0.06	0.30	0.30		
23	Soda								
24	Carbonic acid	0.10	0.10	0.19	0.19	0.10	0.10	7.12	7.14
25	Sulphuric acid								
26	Phosphoric acid	0.158	0.158	0.003	0.003	0.002	0.002	0.139	0.139
27	Titanic acid			Trace.	Trace.	0.075	0.075		
28	Carbon in carbonaceous matter								
29	Hygroscopic water	0.04				0.10		0.23	
30	Water of composition	2.75	2.75	0.55	0.55	0.72	0.72	1.29	1.29
	Total	100.055	100.055	99.986	99.986	99.99	99.99	100.079	100.079
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	14.26	14.27	1.55	1.55	7.31	7.32	4.08	4.09
1	Silica	13.85	13.86	1.23	1.23	6.23	6.24	3.94	3.95
2	Alumina	0.44*	0.44*	0.21	0.21	0.72	0.72	0.17	0.17
3	Iron, protoxide								
4	Lime			0.02	0.02	0.04	0.04		
5	Magnesia			0.01	0.01	0.05	0.05		
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa			0.06	0.06	0.30	0.30		
10	Soda								
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	14.29	14.30	1.53	1.53	7.34	7.35	4.11	4.12

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

86		87		88		89		143		537		538		
State: MICHIGAN. *County:* Marquette. *Location:* McComber mine. *Analysis No.:* 86. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Hematite. *Remarks:* From stope at west end of main pit near north wall.		*State:* MICHIGAN. *County:* Marquette. *Location:* McComber mine. *Analysis No.:* 87. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Hematite. *Remarks:* From bottom of shaft about 130 feet west of engine-house, west side of shaft.		*State:* MICHIGAN. *County:* Marquette. *Location:* New York mine. *Analysis No.:* 88. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Specular. *Remarks:* From southeastern part of pit No. 1.		*State:* MICHIGAN. *County:* Marquette. *Location:* New York mine. *Analysis No.:* 89. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Specular. *Remarks:* From 200 tons of ore from shaft near the Beardsley pit.		*State:* MICHIGAN. *County:* Marquette. *Location:* Keystone mine. *Analysis No.:* 143. *Sampler:* Willis. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From 2,000 tons at "River furnaces" of Cleveland Rolling Mill Company.		*State:* MISSOURI. *County:* Iron. *Location:* Shepherd Mountain, Sec. 31, T. 34, R. 4 E. *Analysis No.:* 537. *Sampler:* Chauvenet. *Chemist:* Whitfield. *Kind of ore:* Specular. *Remarks:* From west cut.		*State:* MISSOURI. *County:* Iron. *Location:* Pilot Knob, Sec. 29, T. 34, R. 4 E. *Analysis No.:* 538. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Specular. *Remarks:* From lower tunnel.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
4.329	.....	4.575	.....	.....	.....	.....	.....	4.597	.....	.....	.....	.....	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.040	0.040	0.010	0.010	0.060	0.060	0.030	0.030	0.055	0.055	0.077	0.077	0.020	0.02	1
0.028	0.028	0.026	0.026	0.062	0.062	0.195	0.195	0.314	0.315	0.013	0.013	0.005	0.005	2
59.27	59.44	55.47	55.80	67.34	67.41	63.81	63.81	59.17	59.34	65.39	65.63	59.52	59.59	3
5.31	5.32	4.04	4.06	1.89	1.89	3.04	3.04	7.61	7.63	3.18	3.19	12.17	12.19	1
.....	.....	.....	.....	0.81	0.81	3.08	3.08	11.36	11.39	1.76	1.77	0.78	0.78	2
84.63	84.87	79.23	79.71	95.22	95.32	87.69	87.69	71.88	72.08	91.36	91.69	84.16	84.26	3
3.57	3.58	3.04	3.06	0.81	0.81	3.04	3.04	3.45	3.46	1.37	1.37	2.21	2.21	4
0.44	0.44	1.36	1.37	.....	.....	Trace.	Trace.	0.04	0.04	Trace.	Trace.	.....	.....	5
0.11	0.11	8.23	8.28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.15	0.15	0.11	0.11	0.29	0.29	0.67	0.67	1.34	1.34	0.43	0.43	0.04	0.04	8
0.12	0.12	0.14	0.14	.....	.....	0.39	0.39	0.56	0.56	0.10	0.10	0.04	0.04	9
0.075	0.075	0.019	0.019	0.112	0.112	0.056	0.056	0.083	0.083	0.143	0.144	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	0.11	0.11	.....	.....	.....	.....	.....	.....	.....	.....	0.10	0.10	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Trace.	Trace.	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.02	0.02	0.15	0.15	0.11	0.11	0.33	0.33	0.92	0.92	0.11	0.11	0.15	0.15	22
.....	.....	0.01	0.01	.....	.....	.....	.....	0.86	0.86	0.05	0.05	0.07	0.07	23
0.13	0.13	0.11	0.11	0.09	0.09	0.12	0.12	0.10	0.10	0.09	0.09	0.04	0.04	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.05	0.05	25
0.065	0.065	0.060	0.060	0.142	0.142	0.448	0.448	0.720	0.722	0.029	0.029	0.011	0.011	26
.....	.....	.....	.....	.....	.....	.....	.....	0.49	0.49	.....	.....	.....	.....	27
.....	.....	.....	.....	.....	.....	.....	.....	0.12	0.12	0.01	0.01	.....	.....	28
0.27	.....	0.60	.....	0.10	.....	.....	.....	0.28	.....	0.36	.....	0.12	.....	29
5.19	5.20	2.90	2.92	0.40	0.40	1.17	1.17	0.23	0.23	1.00	1.00	0.37	0.37	30
100.080	100.080	100.109	100.109	99.974	99.974	100.034	100.034	100.043	100.025	99.992	99.983	100.311	100.311	
7.92	7.94	5.97	6.01	2.88	2.88	4.99	4.99	11.61	11.64	4.27	4.28	13.78	13.80	
5.31	5.32	4.04	4.06	1.89	1.89	3.04	3.04	7.61	7.63	3.18	3.19	12.17	12.19	1
2.55	2.56	1.68*	1.69*	0.86	0.86	1.55	1.55	2.48	2.49	0.87*	0.87*	1.11*	1.11*	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.09	0.09	0.06	0.06	0.04	0.04	4
0.01	0.01	0.07	0.07	.....	.....	.....	.....	0.11	0.11	.....	.....	0.04	0.04	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.02	0.02	0.15	0.15	0.11	0.11	0.33	0.33	0.54	0.54	0.11	0.11	0.15	0.15	9
.....	.....	0.01	0.01	.....	.....	.....	.....	0.65	0.65	0.05	0.05	0.07	0.07	10
.....	.....	.....	.....	.....	.....	.....	.....	0.147	0.147	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.15	0.15	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
7.90	7.92	5.96	5.99	2.87	2.87	4.96	4.96	11.627	11.657	4.27	4.28	13.73	13.75	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		539		550		565		566	
		State: MISSOURI. *County:* Iron. *Location:* Pilot Knob, Sec. 29, T. 34, R. 4 E. *Analysis No.:* 539. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Specular. *Remarks:* From upper tunnel on driving face.		*State:* MISSOURI. *County:* Crawford. *Location:* Cherry Valley mine, Sec 4, T. 37, R. 3 W. *Analysis No.:* 550. *Sampler:* Chauvenet. *Chemist:* King. *Kind of ore:* Blue specular. *Remarks:* From all parts of bottom of pit No. 1, and 10 feet up side.		*State:* MISSOURI. *County:* Dent. *Location:* Riverside bank, Sec. 2, T. 33, R. 5 W. *Analysis No.:* 565. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Blue specular. *Remarks:* From 300 tons of ore from main part of pit.		*State:* MISSOURI. *County:* Dent. *Location:* Riverside bank, Sec. 2, T. 33, R. 5 W. *Analysis No.:* 566. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Hematite. *Remarks:* From face of ore.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity								
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.320	0.320	0.159	0.159	0.020	0.020	0.179	0.180
2	Phosphorus	0.018	0.018	0.022	0.022	0.029	0.029	0.063	0.063
3	Iron, metallic	52.57	52.60	65.87	65.96	63.90	63.90	64.05	64.31
1	Silica	18.71	18.72	3.06	3.06	7.15	7.15	2.56	2.57
2	Iron, protoxide	0.87	0.87	0.82	0.82	1.19	1.19	0.46	0.46
3	Iron, peroxide	73.13	74.17	93.01	93.14	89.93	89.93	90.77	91.13
4	Alumina	2.87	2.87	1.27	1.27	0.81	0.81	1.35	1.36
5	Manganese, protoxide								
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	0.04	0.04	0.28	0.28	0.34	0.34	0.13	0.13
9	Magnesia	0.06	0.06	0.07	0.07	0.09	0.09	0.06	0.06
10	Iron, disulphide			0.255	0.255	0.037	0.037	0.337	0.338
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide	0.51	0.51						
15	Nickel, sulphide								
16	Nickel, oxide								
17	Cobalt, sulphide								
18	Cobalt, oxide								
19	Copper, sulphide								
20	Lead								
21	Antimony, sulphide								
22	Potassa	0.33	0.33						
23	Soda	0.14	0.14						
24	Carbonic acid	0.08	0.08	0.04	0.04	0.13	0.13	0.12	0.12
25	Sulphuric acid	0.80	0.80	0.06	0.06				
26	Phosphoric acid	0.041	0.041	0.051	0.051	0.066	0.066	0.143	0.144
27	Titanic acid								
28	Carbon in carbonaceous matter	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.02
29	Hygroscopic water	0.05		0.14				0.40	
30	Water of composition	0.43	0.43	0.98	0.98	0.15	0.15	3.45	3.46
	Total	100.071	100.071	100.056	100.046	99.903	99.903	99.800	99.792
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	23.74	23.76	3.39	3.39	7.95	7.95	3.56	3.57
1	Silica	18.71	18.72	3.06	3.06	7.15	7.15	2.56	2.57
2	Alumina	2.19*	2.19*	0.16	0.16	0.80	0.80	1.01	1.01
3	Iron, protoxide								
4	Lime	0.04	0.04	0.13	0.13	0.01	0.01	0.02	0.02
5	Magnesia	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.04
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa	0.33	0.33						
10	Soda	0.14	0.14						
11	Phosphoric acid								
12	Barium, sulphate	2.31	2.31						
13	Titanic acid								
14	Chromium sesquioxide								
	Total	23.78	23.79	3.40	3.40	8.01	8.01	3.63	3.64

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

302		308		311		318		325		714		738		
State: NEW JERSEY. *County:* Sussex. *Location:* Andover mine, Andover. *Analysis No.:* 302. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From 80 tons of sorted ore on dock.		*State:* NEW JERSEY. *County:* Sussex. *Location:* Pike's Peak or Furnace vein, Hardyston. *Analysis No.:* 308. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From 150 tons at Franklin furnace.		*State:* NEW JERSEY. *County:* Sussex. *Location:* Pardee (Ogden mines), Sparta. *Analysis No.:* 311. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From 2,500 tons at mine.		*State:* NEW JERSEY. *County:* Morris. *Location:* Hurd or Hurdtown, Jefferson. *Analysis No.:* 318. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Magnetite. *Remarks:* From about 110 tons on cars at mine.		*State:* NEW JERSEY. *County:* Warren. *Location:* Shields, Beattyestown hematite, Mansfield. *Analysis No.:* 325. *Sampler:* Putnam. *Chemist:* Blair. *Kind of ore:* Limonite. *Remarks:* From 25 tons at Stanhope furnace.		*State:* NEW YORK. *County:* Richmond. *Location:* New Dorp mine, Staten Island. *Analysis No.:* 714. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Limonite. *Remarks:* From 3,000 tons of washed ore at mine.		*State:* NEW YORK. *County:* Putnam. *Location:* Tilly Foster mine, South East. *Analysis No.:* 738. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Magnetite. *Remarks:* From mine, south side room No. 2, N. 300-foot level, from near foot-wall, to point one-third the way across the vein.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
4.086	.....	3.576	.....	.....	.....	.....	.....	3.494	.....	3.988	.....	.....	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
2.527	2.530	0.439	0.439	0.113	0.113	0.096	0.096	0.041	0.041	0.391	0.400	0.548	0.550	1
0.022	0.022	0.033	0.033	1.067	1.067	0.169	0.169	0.257	0.258	0.059	0.060	0.015	0.015	2
36.91	36.95	33.15	33.17	59.23	59.23	66.02	66.05	42.73	42.96	39.72	40.63	48.91	49.05	3
21.86	21.89	1.67	1.67	7.63	7.63	4.06	4.06	19.24	19.34	14.19	14.51	12.18	12.22	1
15.42	15.44	14.43	14.44	25.34	25.34	29.78	29.80	.....	.....	0.55	0.56	21.99	22.05	2
32.56	32.60	30.69	30.71	56.37	56.37	61.13	61.16	60.99	61.32	55.95	57.23	44.75	44.88	3
3.97	3.97	0.28	0.28	3.08	3.08	1.73	1.73	4.72	4.75	8.59	8.79	0.79	0.79	4
0.32	0.32	2.90	2.90	0.34	0.34	Trace.	Trace.	1.81	1.82	0.52	0.53	0.10	0.10	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.91	1.95	.....	.....	7
18.57	18.59	17.63	17.64	4.09	4.09	1.29	1.29	0.34	0.34	0.18	0.18	3.10	3.11	8
0.16	0.16	7.53	7.53	0.27	0.27	0.43	0.43	0.70	0.70	3.60	3.68	11.72	11.75	9
4.530	4.540	0.780	0.780	0.212	0.212	0.144	0.144	0.077	0.077	0.293	0.300	1.031	1.031	10
.....	.....	0.47	0.47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
0.24	0.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
0.01	0.01	.....	.....	.....	.....	.....	.....	.....	.....	0.55	0.56	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	0.06	0.06	.....	.....	.....	.....	16
0.01	0.01	.....	.....	.....	.....	.....	.....	.....	.....	0.17	0.17	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	0.04	0.04	.....	.....	.....	.....	18
0.12	0.12	0.03	0.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
Trace.	Trace.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	0.05	0.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.05	0.05	.....	.....	.....	.....	0.03	0.03	1.46	1.47	0.19	0.19	.....	.....	22
.....	.....	.....	.....	.....	.....	0.09	0.09	0.10	0.10	0.40	0.41	.....	.....	23
1.58	1.58	22.25	22.27	0.06	0.06	0.26	0.26	0.06	0.06	0.22	0.22	0.40	0.40	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
0.051	0.051	0.077	0.077	2.444	2.444	0.389	0.389	0.588	0.591	0.135	0.138	0.034	0.034	26
0.13	0.13	.....	.....	0.09	0.09	0.14	0.14	.....	.....	.....	.....	.....	.....	27
.....	.....	0.98*	0.98*	.....	.....	0.03	0.03	0.11	0.11	0.13	0.13	.....	.....	28
0.12	.....	0.06	.....	.....	.....	0.05	.....	0.52	.....	2.21	.....	0.29	.....	29
0.33	0.33	0.18	0.18	0.38	0.38	0.24	0.24	8.88	8.92	10.20	10.41	3.79	3.80	30
100.031	100.031	100.007	100.007	100.306	100.306	99.793	99.793	99.695	99.698	99.988	99.958	100.175	100.165	
23.67	23.70	2.41	2.41	9.69	9.69	5.36	5.36	24.91	25.04	21.26	21.74	13.15	13.19	
21.86	21.89	1.67	1.67	7.63	7.63	4.06	4.06	19.24	19.34	14.19	14.51	12.18	12.22	1
1.08	1.08	0.45	0.45	1.99†	1.99†	0.17	0.17	4.06†	4.08†	3.47	3.55	0.32†	0.32†	2
.....	.....	.....	.....	.....	.....	0.58	0.58	.....	.....	.....	.....	.....	.....	3
0.51	0.51	0.19	0.19	0.04	0.04	0.27	0.27	0.07	0.07	.....	.....	0.29	0.29	4
0.16	0.16	0.08	0.08	0.02	0.02	0.17	0.17	0.48	0.48	2.92	2.99	0.27	0.27	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.05	0.05	.....	.....	.....	.....	0.03	0.03	1.02	1.02	0.03	0.03	.....	.....	9
.....	.....	.....	.....	.....	.....	0.09	0.09	0.03	0.03	0.07	0.07	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.01	0.01	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.68	0.69	.....	.....	14
23.69	23.66	2.39	2.39	9.68	9.68	5.37	5.37	24.90	25.02	21.37	21.85	13.06	13.10	

*Graphite.

† With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		743 *State:* NEW YORK. *County:* Putnam. *Location:* Tilly Foster mine, South East. *Analysis No.:* 743. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Magnetite. *Remarks:* From cars at mine; ore from 110-foot level, Duncan shaft.		755 *State:* NEW YORK. *County:* Duchess. *Location:* Fishkill, East Fishkill. *Analysis No.:* 755. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Limonite. *Remarks:* From 70 tons washed and rock ore on cars, principally washed ore.		762 *State:* NEW YORK. *County:* Duchess. *Location:* Gridley & Sons, Amenia. *Analysis No.:* 762. *Sampler:* Putnam. *Chemist:* Whitfield. *Kind of ore:* Limonite. *Remarks:* From 200 tons of washed ore at mine.		158 *State:* NORTH CAROLINA. *County:* Chatham. *Location:* Opening No. 11, 90-foot shaft, Ore Hill. *Analysis No.:* 158. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Limonite. *Remarks:* From 1½ tons of ore near shaft, 90 feet deep.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity								
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	**Sulphur**	0.538	0.539	0.143	0.144	0.152	0.153	0.263	0.270
2	**Phosphorus**	0.007	0.007	0.073	0.074	0.413	0.415	0.390	0.400
3	**Iron, metallic**	49.66	49.74	40.92	41.29	48.99	49.25	57.23	58.76
1	Silica	10.81	10.83	24.68	24.90	11.94	12.00	1.28	1.30
2	Iron, protoxide	23.36	23.40	0.25	0.25	0.30	0.30	0.23	0.24
3	Iron, peroxide	44.30	44.37	57.99	58.52	67.77	68.12	81.19	83.36
4	Alumina	1.11	1.11	3.82	3.85	4.10	4.12	2.38	2.44
5	Manganese, protoxide	0.04	0.04	0.94	0.95	0.65	0.65		
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	1.19	1.19	1.13	1.14	1.60	1.61	0.14	0.14
9	Magnesia	16.33	16.36	0.41	0.41	0.48	0.48	0.01	0.01
10	Iron, disulphide	1.010	1.010	0.279	0.270	0.286	0.287	0.473	0.485
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide							0.02	0.02
16	Nickel, oxide								
17	Cobalt, sulphide								
18	Cobalt, oxide								
19	Copper, sulphide							0.02	0.02
20	Lead								
21	Antimony, sulphide								
22	Potassa	0.12	0.12			1.12	1.13	0.14	0.14
23	Soda	0.22	0.22			0.34	0.34	0.01	0.01
24	Carbonic acid	0.28	0.28	0.25	0.25	0.34	0.34	0.18	0.18
25	Sulphuric acid	0.05	0.05			0.06	0.06		
26	Phosphoric acid	0.015	0.015	0.167	0.169	0.950	0.950	0.893	0.917
27	Titanic acid							1.04	1.07
28	Carbon in carbonaceous matter	0.01	0.01	0.06	0.06	0.08	0.08	0.17	0.17
29	Hygroscopic water	0.16		0.87		0.51		2.57	
30	Water of composition	0.89	0.89	9.48	9.56	9.76	9.80	9.32	9.54
	Total	99.895	99.895	100.317	100.329	100.286	100.267	100.066	100.042
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	12.07	12.09	27.21	27.46	15.44	15.52	1.82	1.860
1	Silica	10.81	10.83	24.68	24.90	11.94	12.00	1.28	1.30
2	Alumina	0.68*	0.68*	1.94*	1.96*	2.15*	2.16*	0.48	0.49
3	Iron, protoxide								
4	Lime	0.30	0.30	0.27	0.27	0.32	0.32	0.06	0.06
5	Magnesia	0.45	0.45	0.23	0.23	0.20	0.20	0.01	0.01
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa					0.92	0.92		
10	Soda					0.10	0.10		
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	12.24	12.26	27.12	27.36	15.63	15.70	1.83	1.86

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

165		170		184		188		189		402		
State: NORTH CAROLINA. *County:* Rockingham. *Location:* Dannemora, near Brown's summit. *Analysis No.:* 165. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Magnetite. *Remarks:* From 5 tons of ore from drift 70 feet below the surface.		*State:* NORTH CAROLINA. *County:* Stokes. *Location:* Roger's bank, near Danbury. *Analysis No.:* 170. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Magnetite. *Remarks:* From 2 tons of ore near old pit.		*State:* NORTH CAROLINA. *County:* Lincoln. *Location:* Big bank, near Lincolnton. *Analysis No.:* 184. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Magnetite and hematite. *Remarks:* From ore mined in shaft near water-level.		*State:* NORTH CAROLINA. *County:* Gaston. *Location:* Mine mountain, near Kings mountain. *Analysis No.:* 188. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Limonite. *Remarks:* From 15 tons of ore near cut.		*State:* NORTH CAROLINA. *County:* Gaston. *Location:* Mine mountain, near Kings mountain. *Analysis No.:* 189. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Limonite. *Remarks:* From 5 tons of ore near opening.		*State:* NORTH CAROLINA. *County:* Orange. *Location:* Chapel Hill, Chapel Hill. *Analysis No.:* 402. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Specular. *Remarks:* From 10-foot vein in main shaft.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
4.453	.....	4.519	.....	4.495	.....	4.180	.....	4.391	.....	3.551	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.089	0.089	0.179	0.179	0.086	0.086	0.090	0.090	0.112	0.113	0.153	0.153	1
0.023	0.023	0.001	0.001	0.013	0.013	0.009	0.009	0.005	0.005	0.057	0.057	2
48.31	48.41	58.26	58.30	58.38	58.56	61.00	61.20	58.37	58.73	37.91	37.94	3
4.70	4.71	12.29	12.30	9.14	9.17	1.63	1.64	5.28	5.31	43.00	43.04	1
23.51	23.56	16.88	16.89	8.68	8.71	0.24	0.24	0.29	0.29	1.45	1.45	2
43.05	43.14	64.24	64.29	73.67	73.89	86.75	87.04	82.92	83.43	52.34	52.39	3
8.66	8.68	0.58	0.58	2.45	2.46	0.25	0.25	1.33	1.34	2.07	2.07	4
0.15	0.15	.....	.....	0.06	0.06	1.00	1.00	4.11	4.13	Trace.	Trace.	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
0.34	0.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
1.42	1.42	1.99	1.99	0.27	0.27	0.24	0.24	0.52	0.52	0.10	0.10	8
2.96	2.97	3.31	3.31	4.32	4.33	0.13	0.13	0.16	0.16	0.02	0.02	9
0.133	0.133	0.336	0.336	0.140	0.140	0.169	0.169	0.211	0.212	0.287	0.287	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
0.01	0.01	.....	.....	.....	.....	Trace.	Trace.	Trace.	Trace.	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
0.03	0.03	.....	.....	.....	.....	Trace.	Trace.	Trace.	Trace.	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
0.01	0.01	.....	.....	0.05	0.05	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.03	0.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22
0.05	0.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
0.07	0.07	0.08	0.08	0.06	0.06	0.15	0.15	0.14	0.14	0.05	0.05	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
0.052	0.052	0.002	0.002	0.030	0.030	0.023	0.023	0.017	0.017	0.131	0.131	26
13.71	13.74	.....	.....	.....	.....	.....	.....	.....	.....	Trace.	Trace.	27
0.06	0.06	0.01	0.01	0.01	0.01	0.06	0.06	0.03	0.03	0.01	0.01	28
0.21	.....	0.07	.....	0.30	.....	0.33	.....	0.62	.....	0.09	.....	29
0.96	0.96	0.38	0.38	1.07	1.07	9.30	9.30	4.24	4.27	0.55	0.55	30
100.115	100.115	100.168	100.168	100.250	100.250	100.272	100.272	99.868	99.849	100.098	100.098	
28.00	28.06	21.15	21.16	14.32	14.36	1.63	1.64	5.59	5.62	44.49	44.53	
4.70	4.71	12.29	12.30	9.14	9.17	1.63	1.64	5.28	5.31	43.00	43.04	1
9.75	9.77	4.34	4.34	1.83	1.84	Trace.	Trace.	0.26	0.26	1.40	1.40	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
0.56	0.56	1.69	1.69	0.20	0.20	Trace.	Trace.	0.14	0.14	0.07	0.07	4
0.72	0.72	2.92	2.92	3.17	3.18	.....	.....	.....	.....	0.02	0.02	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.03	0.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
0.05	0.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
0.045	0.045	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
11.82	11.84	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
27.675	27.725	21.24	21.25	14.34	14.39	1.63	1.64	5.68	5.71	44.49	44.53	

TABLE 26.—*Complete analyses of iron ores*—Continued.

		407		409		295		299	
		State: NORTH CAROLINA. *County:* Mitchell. *Location:* Cranberry, Big Yellow mountain. *Analysis No.:* 407. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Magnetite. *Remarks:* Pure magnetite from near southern end of workings.		*State:* NORTH CAROLINA. *County:* Mitchell. *Location:* Cranberry, Big Yellow mountain. *Analysis No.:* 409. *Sampler:* Willis. *Chemist:* Pitman. *Kind of ore:* Magnetite. *Remarks:* Magnetite, with epidote from opening 100 yards N. E. of location of No. 407.		*State:* TENNESSEE. *County:* Rhea. *Location:* Hill and Tarwater, Rhea Springs. *Analysis No.:* 295. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Fossil. *Remarks:* From whole vein.		*State:* TENNESSEE. *County:* Lawrence. *Location:* Napier's, near Napier furnace. *Analysis No.:* 299. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Limonite. *Remarks:* From stock pile at Napier furnace.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity	4.753		3.637		4.007		3.714	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.115	0.115	0.128	0.128	0.109	0.110	0.070	0.070
2	Phosphorus	0.004	0.004	0.010	0.010	0.506	0.510	0.519	0.522
3	Iron, metallic	64.64	64.87	32.37	32.49	51.71	52.11	52.61	52.88
1	Silica	5.27	5.29	29.99	30.10	10.88	10.97	6.19	6.22
2	Iron, protoxide	26.68	26.77	18.93	19.00	0.69	0.69	0.35	0.35
3	Iron, peroxide	62.57	62.79	25.05	25.14	72.96	73.53	75.17	75.56
4	Alumina	1.18	1.18	10.07	10.11	6.89	6.94	3.57	3.59
5	Manganese, protoxide	0.22	0.22	0.76	0.76	0.42	0.42	0.92	0.92
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	1.46	1.47	11.33	11.37	2.26	2.28	0.26	0.26
9	Magnesia	0.55	0.55	1.78	1.78	0.73	0.73	0.38	0.38
10	Iron, disulphide	0.200	0.200	0.180	0.180	0.205	0.206	0.130	0.131
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide	0.04	0.04	0.09	0.09				
16	Nickel, oxide								
17	Cobalt, sulphide								
18	Cobalt, oxide								
19	Copper, sulphide								
20	Lead								
21	Antimony, sulphide								
22	Potassa								
23	Soda								
24	Carbonic acid	0.08	0.08	0.07	0.07	0.07	0.07	0.25	0.25
25	Sulphuric acid								
26	Phosphoric acid	0.007	0.007	0.024	0.024	1.158	1.168	1.189	1.195
27	Titanic acid	0.95	0.95						
28	Carbon in carbonaceous matter					0.01	0.01	0.09	0.09
29	Hygroscopic water	0.35		0.37		0.77		0.43	
30	Water of composition	0.49	0.49	1.49	1.50	2.94	2.96	11.15	11.12
	Total	100.047	100.037	100.134	100.124	99.983	99.974	100.079	100.066
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	7.20	7.23	43.69	43.85	13.18	13.28	7.59	7.63
1	Silica	5.27	5.29	29.99	30.10	10.88	10.97	6.19	6.22
2	Alumina	1.41	1.42	4.63*	4.65*	1.88*	1.89*	1.29*	1.30*
3	Iron, protoxide			3.78	3.79				
4	Lime	0.52	0.52	4.62	4.64	0.15	0.15	0.05	0.05
5	Magnesia	0.26	0.26	0.56	0.56	0.25	0.25	0.11	0.11
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa			0.10	0.10				
10	Soda			0.07	0.07				
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	7.46	7.49	43.75	43.91	13.16	13.26	7.64	7.68

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

487		[illegible]		501		527		[illegible]		914		
State: TENNESSEE. *County:* Monroe. *Location:* Hale bank, Tellico. *Analysis No.:* 487. *Sampler:* Willis. *Chemist:* Whitfield. *Kind of ore:* Limonite. *Remarks:* From 500 tons of ore at bank.		*State:* TENNESSEE. *County:* Blount. *Location:* Wilson bank, near Maryville. *Analysis No.:* 495. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From pile of ore for roasting.		*State:* TENNESSEE. *County:* Wayne. *Location:* Marion furnace, Clifton. *Analysis No.:* 501. *Sampler:* Chauvenet. *Chemist:* White. *Kind of ore:* Hematite. *Remarks:* From exposed masses and streaks, and from loose lumps in old pit.		*State:* TENNESSEE. *County:* Stewart. *Location:* "La Grange" and "Sheridan" banks. *Analysis No.:* 527. *Sampler:* Chauvenet. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From 300 to 400 tons at furnace.		*State:* TENNESSEE. *County:* Stewart. *Location:* Outlaw's mine, near Indian mound. *Analysis No.:* 530. *Sampler:* Chauvenet. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From small pit; "pipe ore".		*State:* TENNESSEE. *County:* Cocke. *Location:* W. R. Smith's land, Wolf Creek. *Analysis No.:* 914 *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Specular. *Remarks:* From upper three feet of vein.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
.....	.....	3.644	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.147	0.148	0.184	0.188	0.108	0.110	0.069	0.069	0.193	0.195	0.399	0.399	1
0.445	0.450	0.149	0.147	0.314	0.319	0.237	0.238	0.197	0.199	0.016	0.016	2
54.78	55.22	53.54	54.66	54.86	55.70	50.91	51.20	55.15	55.64	45.68	45.73	3
6.78	6.83	5.01	5.12	6.03	6.12	12.76	12.83	6.65	6.72	26.59	26.62	1
0.37	0.37	0.34	0.35	0.92	0.93	0.36	0.36	0.57	0.57	0.96	0.96	2
77.65	78.28	76.10	77.70	77.21	78.40	72.28	72.69	77.95	78.63	63.68	63.76	3
1.17	1.18	4.04	4.12	1.83	1.85	2.83	2.84	2.69	2.71	5.05	5.06	4
.....	.....	Trace.	Trace.	0.09	0.09	0.31	0.31	Trace.	Trace.	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.34	0.34	0.02	0.02	2.21	2.24	0.42	0.42	0.18	0.18	0.18	0.18	8
0.32	0.32	0.21	0.21	0.13	0.13	0.17	0.17	0.17	0.17	0.06	0.06	9
0.275	0.277	.....	.....	0.203	0.206	0.096	0.096	0.333	0.336	0.742	0.742	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	0.54	0.55	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	0.10	0.10	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.41	0.41	.....	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	22
0.25	0.25	.....	.....	.....	.....	.....	.....	.....	.....	0.17	0.17	23
0.13	0.13	0.32	0.33	0.21	0.21	0.19	0.19	0.09	0.09	0.04	0.04	24
.....	.....	0.02	0.02	.....	.....	0.04	0.04	0.04	0.04	0.01	0.01	25
1.260	1.270	0.332	0.339	0.719	0.730	0.543	0.546	0.452	0.456	0.036	0.036	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
0.10	0.10	0.06	0.06	0.11	0.11	0.10	0.10	0.10	0.10	0.03	0.03	28
0.79	.....	2.03	.....	1.51	.....	0.57	.....	0.86	.....	0.12	.....	29
10.28	10.35	10.91	11.11	9.17	9.30	94.5	9.50	10.04	10.12	0.61	0.61	30
100.125	100.107	100.032	100.029	100.342	100.316	100.119	100.092	100.125	100.122	100.078	100.078	
8.14	8.20	6.70	6.84	7.21	7.32	13.52	13.59	7.51	7.58	32.71	32.75	
6.78	6.83	5.01	5.12	6.03	6.12	12.76	12.83	6.65	6.72	26.59	26.62	1
0.67*	0.67*	1.52	1.55	1.11	1.13	0.58	0.58	0.65	0.66	3.97	3.97	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
0.28	0.28	0.02	0.02	0.10	0.10	0.13	0.13	0.12	0.12	0.18	0.18	4
0.23	0.23	0.14	0.14	0.02	0.02	0.06	0.06	0.04	0.04	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.27	0.27	.....	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	9
0.01	0.01	.....	.....	.....	.....	.....	.....	.....	.....	0.17	0.17	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
8.24	8.29	6.69	6.83	7.26	7.37	13.53	13.60	7.46	7.54	32.71	32.74	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		931		935		952		960	
		State: TENNESSEE. *County:* Carter. *Location:* Queen's Station bank, Elizabethton. *Analysis No.:* 931. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From pieces of ore at different openings.		*State:* TENNESSEE. *County:* Johnson. *Location:* Wash Place bank, Little Doe creek. *Analysis No.:* 935. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From 5 tons of ore at bank.		*State:* TENNESSEE. *County:* Johnson. *Location:* Baker bank, Roanes creek. *Analysis No.:* 952. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From pieces left at old pits.		*State:* TENNESSEE. *County:* Sullivan. *Location:* Sharp's bank, near Bristol. *Analysis No.:* 960. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Specular with magnetite. *Remarks:* From ore found on Gray's Hill.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity								
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.139	0.141	0.084	0.085	0.119	0.119	0.163	0.164
2	Phosphorus	0.154	0.156	0.214	0.216	0.160	0.161	0.038	0.038
3	Iron, metallic	57.65	58.36	54.18	54.72	57.68	57.89	56.47	56.69
1	Silica	4.57	4.62	5.69	5.75	3.80	3.81	6.09	6.11
2	Iron, protoxide	0.38	0.38	0.16	0.16	0.27	0.27	9.70	9.74
3	Iron, peroxide	81.81	82.77	77.08	77.85	81.94	82.25	69.72	69.98
4	Alumina	3.66	3.70	2.38	2.40	1.18	1.18	0.88	0.88
5	Manganese, protoxide	0.49	0.49	0.93	0.94	0.76	0.76	0.15	0.15
6	Manganese, dioxide								
7	Chromium, sesquioxide								
8	Lime	0.32	0.32	1.16	1.17	0.08	0.08	4.73	4.75
9	Magnesia	0.25	0.25	0.01	0.01	0.22	0.22	2.02	2.03
10	Iron, disulphide	0.256	0.259	0.153	0.155	0.214	0.214	0.260	0.261
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel, sulphide							Trace.	Trace.
16	Nickel, oxide								
17	Cobalt, sulphide					Trace.	Trace.		
18	Cobalt, oxide								
19	Copper, sulphide					Trace.	Trace.		
20	Lead								
21	Antimony, sulphide								
22	Potassa								
23	Soda								
24	Carbonic acid	0.09	0.09	0.39	0.39	0.14	0.14	4.97	4.99
25	Sulphuric acid	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.06
26	Phosphoric acid	0.352	0.356	0.488	0.493	0.367	0.368	0.087	0.087
27	Titanic acid								
28	Carbon in carbonaceous matter	0.10	0.10	0.18	0.18	0.11	0.11	0.01	0.01
29	Hygroscopic water	1.15		0.97		0.36		0.38	
30	Water of composition	6.60	6.67	10.46	10.55	10.50	10.53	1.06	1.06
	Total	100.038	100.015	100.061	100.058	99.951	99.942	100.117	100.108
	ANALYSIS OF INSOLUBLE SILICEOUS MATTER.								
	Per cent. of insoluble siliceous matter	6.15	6.22	6.65	6.72	4.46	4.48	6.47	6.50
1	Silica	4.57	4.62	5.69	5.75	3.80	3.81	6.09	6.11
2	Alumina	1.22	1.23	0.71	0.72	0.65	0.65	0.38	0.38
3	Iron, protoxide								
4	Lime	0.32	0.32	0.26	0.26				
5	Magnesia	0.08	0.08			0.05	0.05	Trace.	Trace.
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa								
10	Soda								
11	Phosphoric acid								
12	Barium, sulphate								
13	Titanic acid								
14	Chromium, sesquioxide								
	Total	6.19	6.25	6.66	6.73	4.50	4.51	6.47	6.49

TABLE 26.—*Complete analyses of iron ores*—Continued.

967		968		970		687		605		606		615		
State: TENNESSEE. *County:* Carter. *Location:* Hodge bank, Stoney Creek. *Analysis No.:* 967. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From stock pile at furnace.		*State:* TENNESSEE. *County:* Carter. *Location:* Taylor bank, Carter furnace, Stoney Creek. *Analysis No.:* 968. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite. *Remarks:* From washed ore at Carter furnace.		*State:* TENNESSEE. *County:* Carter. *Location:* Specular bank, Carter furnace, Stoney Creek. *Analysis No.:* 970. *Sampler:* Willis. *Chemist:* King. *Kind of ore:* Limonite and specular. *Remarks:* From stock pile at Carter furnace.		*State:* VERMONT. *County:* Windsor. *Location:* Tyson furnace, Plymouth. *Analysis No.:* 687. *Sampler:* Benton. *Chemist:* Richmond. *Kind of ore:* Siderite. *Remarks:* From stock pile at furnace.		*State:* VIRGINIA. *County:* Amherst. *Location:* Dover & Co.'s No. 11, Riverville. *Analysis No.:* 605. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Specular and magnetite. *Remarks:* From heads of all drifts, main deposit.		*State:* VIRGINIA. *County:* Amherst. *Location:* Dover & Co.'s, No. 11, Riverville. *Analysis No.:* 606. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Micaceous hematite and magnetite. *Remarks:* From further ends of drifts, between shafts Nos. 2 and 3; also S. W. of shaft No. 3.		*State:* VIRGINIA. *County:* Franklin. *Location:* Rocky Mt., Franklin C. H. *Analysis No.:* 615. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Magnetite. *Remarks:* From 3 new shafts on westerly deposit, 10 to 20 feet deep.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.098	0.099	0.066	0.067	0.069	0.069	2.158	2.160	0.352	0.352	0.579	0.579	0.364	0.364	1
0.074	0.075	0.056	0.057	0.338	0.339	0.010	0.010	0.103	0.103	0.061	0.061	0.018	0.018	2
34.28	34.68	49.73	50.46	53.96	54.15	32.24	32.27	48.47	48.50	54.88	54.92	53.59	53.66	3
3.38	3.42	13.68	13.87	12.04	12.08	11.31	11.32	21.58	21.60	14.00	14.01	14.67	14.69	1
.....	.....	0.43	0.44	0.87	0.87	40.19	40.22	6.03	6.03	13.67	13.68	26.79	26.82	2
48.95	49.51	70.48	71.52	76.04	76.31	.....	.....	62.35	62.39	63.01	63.05	46.33	46.39	3
2.38	2.41	4.55	4.62	2.46	2.47	3.74	3.74	4.94	4.94	2.93	2.93	2.77	2.77	4
2.72	2.75	1.08	1.10	0.14	0.14	2.56	2.56	.....	.....	.....	.....	0.12	0.12	5
32.29	32.66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.56	0.57	1.56	1.58	0.23	0.23	1.74	1.74	0.28	0.28	0.73	0.73	4.21	4.22	8
0.17	0.17	0.48	0.48	0.10	0.10	7.26	7.27	0.37	0.37	0.26	0.26	2.80	2.80	9
0.041	0.042	0.110	0.112	0.111	0.111	3.747	3.750	0.320	0.320	0.300	0.300	0.681	0.682	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	Trace.	Trace.	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	1.18	1.18	2.11	2.11	.....	.....	14
0.18	0.18	.....	.....	.....	.....	0.24	0.24	.....	.....	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
Trace.	Trace.	.....	.....	.....	.....	Trace.	Trace.	.....	.....	.....	.....	.....	.....	17
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
Trace.	Trace.	.....	.....	.....	.....	0.20	0.20	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	.....	.....	.....	0.99	0.99	0.54	0.54	.....	.....	22
.....	.....	.....	.....	.....	.....	.....	.....	0.14	0.14	0.10	0.10	.....	.....	23
0.25	0.25	0.39	0.39	0.06	0.06	28.29	28.31	0.21	0.21	0.54	0.54	1.01	1.01	24
0.02	0.02	0.02	0.02	0.02	0.02	0.15	0.15	0.45	0.45	1.04	1.04	.....	.....	25
0.166	0.169	0.129	0.131	0.773	0.776	0.023	0.023	0.239	0.239	0.141	0.141	0.042	0.042	26
.....	.....	.....	.....	.....	.....	.....	.....	0.07	0.07	Trace.	Trace.	.....	.....	27
0.04	0.04	0.02	0.02	0.03	0.03	0.22	0.22	.....	.....	.....	.....	0.01	0.01	28
1.14	.....	1.45	.....	0.36	.....	0.08	.....	0.07	.....	0.07	.....	.013	.....	29
7.89	7.97	5.79	5.87	6.71	6.73	0.34	0.34	0.85	0.85	0.52	0.52	0.87	0.87	30
100.177	100.161	100.169	100.153	99.944	99.927	100.090	100.083	100.069	100.059	99.961	99.951	100.433	100.424	
3.67	3.71	14.80	15.01	12.73	12.77	13.28	13.29	28.53	28.55	20.71	20.72	26.53	26.56	
3.38	3.42	13.68	13.87	12.04	12.08	11.31	11.32	21.58	21.60	14.00	14.01	14.67	14.69	1
0.22	0.22	0.91	0.92	0.61	0.61	1.37*	1.37*	4.12*	4.12*	2.92*	2.92*	2.46*	2.46*	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.28	4.29	3
0.20	0.02	0.14	0.14	.....	.....	0.34	0.34	0.01	0.01	0.05	0.05	2.79	2.79	4
0.04	0.04	0.08	0.08	0.07	0.07	0.10	0.10	0.31	0.31	0.21	0.21	2.29	2.29	5
.....	.....	.....	.....	.....	.....	0.06	0.06	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	0.16	0.16	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	Trace.	Trace.	.....	.....	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	0.91	0.91	0.46	0.46	.....	.....	9
.....	.....	.....	.....	.....	.....	.....	.....	0.11	0 11	0.06	0.06	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	0.028	0.028	0.002	0.002	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	1.32	1.32	3.04	3.04	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	0.07	0.07	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
3.66	3.70	14.81	15.01	12.72	12.76	13.34	13.35	28.458	28.478	20.742	20.752	26.49	26.52	

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

		626		632		635		636	
		State: VIRGINIA. *County:* Wythe. *Location:* Johnson bank, Little Red Island creek. *Analysis No.:* 626. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From open cut now worked.		*State:* VIRGINIA. *County:* Smyth. *Location:* Panic furnace property. *Analyses No.:* 632. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From open cut.		*State:* VIRGINIA. *County:* Wythe. *Location:* Ravenscliffe Furnace bank, Sayers & Oglesby furnace. *Analysis No.:* 635. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From pile of washed ore at washer.		*State:* VIRGINIA. *County:* Wythe. *Location:* Ravenscliffe furnace bank, Sayers & Oglesby furnace. *Analysis No.:* 636. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From pile of unwashed ore from same pit as No. 635.	
		Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.
	Specific gravity								
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	Sulphur	0.062	0.063	0.056	0.057	0.094	0.095	0.063	0.064
2	Phosphorus	0.083	0.085	0.125	0.127	0.156	0.158	0.165	0.167
3	Iron, metallic	56.29	57.47	46.61	47.51	56.29	56.97	42.23	42.77
1	Silica	4.94	5.04	11.47	11.69	4.70	4.76	17.64	17.86
2	Iron, protoxide	0.43	0.44			0.44	0.45	0.36	0.36
3	Iron, peroxide	79.85	81.53	66.55	67.81	79.73	80.68	59.79	60.55
4	Alumina	1.69	1.73	5.42	5.53	1.24	1.25	7.88	7.98
5	Manganese, protoxide	0.15	0.15			0.28	0.28	0.57	0.58
6	Manganese, dioxide			3.46	3.53				
7	Chromium, sesquioxide								
8	Lime	0.20	0.20	0.21	0.21	0.10	0.10	0.13	0.13
9	Magnesia	0.60	0.61	0.11	0.11	0.53	0.54	0.82	0.83
10	Iron, disulphide	0.116	0.118	0.050	0.050	0.176	0.178	0.118	0.120
11	Iron, arsenide								
12	Zinc, sulphide								
13	Zinc, oxide								
14	Barium, oxide								
15	Nickel sulphide			0.11	0.11				
16	Nickel, oxide								
17	Cobalt, sulphide			Trace.	Trace.				
18	Cobalt, oxide								
19	Copper, sulphide								
20	Lead								
21	Antimony, sulphide								
22	Potassa	0.07	0.07					0.54	0.55
23	Soda	0.03	0.03					0.13	0.13
24	Carbonic acid	0.39	0.40	0.08	0.08	0.10	0.10	0.14	0.14
25	Suphuric acid								
26	Phosphoric acid	0.191	0.195	0.284	0.290	0.358	0.362	0.374	0.384
27	Titanic acid			0.16	0.16			Trace.	Trace.
28	Carbon in carbonaceous matter	0.09	0.09	0.02	0.02	0.06	0.06	0.03	0.03
29	Hygroscopic water	2.04		1.88		1.17		1.23	
30	Water of composition	9.41	9.59	10.28	10.46	11.07	11.19	10.44	10.55
	Total	100.197	100.193	100.084	100.050	99.954	99.950	100.192	100.194
	ANALYSIS OF INSOLUBLE SILECEOUS MATTER.								
	Per cent. of insoluble sileceous matter	5.80	5.91	13.10	13.35	5.28	5.34	23.92	24.22
1	Silica	4.94	5.04	11.47	11.69	4.70	4.76	17.64	17.86
2	Alumina	0.72*	0.73*	1.50	1.53	0.52*	0.53*	5.20*	5.27*
3	Iron, protoxide								
4	Lime			0.05	0.05	0.06	0.06	0.11	0.11
5	Magnesia	0.05	0.05	0.06	0.06			0.33	0.33
6	Manganese, protoxide								
7	Nickel, sulphide								
8	Zinc, sulphide								
9	Potassa	0.07	0.07					0.54	0.55
10	Soda	0.03	0.03					0.13	0.13
11	Phosphoric acid			0.004	0.004			0.008	0.008
12	Barium, sulphate								
13	Titanic acid							Trace.	Trace.
14	Chromium, sesquioxide								
	Total	5.81	5.92	13.084	13.334	5.28	5.35	23.958	24.258

* With trace of oxide of iron.

TABLE 26.—*Complete analyses of iron ores*—Continued.

652		658		659		[illegible]		674		70		72 and 73		
State: VIRGINIA. *County:* Alleghany. *Location:* Lucy Selina (Longdale) bank, Brushy mountain. *Analysis No.:* 652. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From four pits 4 miles N. E. of furnace.		*State:* VIRGINIA. *County:* Alleghany. *Location:* Lowmoor, Lowmoor station. *Analysis No.:* 658. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From five pits on N. E. side of Fork run.		*State:* VIRGINIA. *County:* Alleghany. *Location:* Lowmoor, Lowmoor station. *Analysis No.:* 659. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From four tunnels on S. W. side of Fork run.		*State:* VIRGINIA. *County:* Rockingham. *Location:* Fox Mountain bank. *Analysis No.:* 665. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite. *Remarks:* From pit ¼ mile S. W. from furnace No. 2.		*State:* VIRGINIA. *County:* Rockingham. *Location:* Raines & Weaver banks, Mount Vernon furnace. *Analysis No.:* 674. *Sampler:* Benton. *Chemist:* Gooch. *Kind of ore:* Limonite and hematite. *Remarks:* From stock pile at furnace.		*State:* WISCONSIN. *County:* Marinette. *Location:* Commonwealth mine, Sec. 32. *Analysis No.:* 70. *Sampler:* Putnam. *Chemist:* Gooch. *Kind of ore:* Martite (?) *Remarks:* From 200 tons of ore at shaft.		*State:* WISCONSIN. *County:* Marinette. *Location:* Commonwealth mine, Sec. 34. *Analysis Nos.:* 72 and 73 *Sampler:* Putnam. *Chemist:* Gooch, Whitfield. *Kind of ore:* Specular. *Remarks:* From 700 tons of ore from 36- and 68-foot veins, and from sides of shaft in 14-foot vein.		
Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	Natural ore.	Dried ore.	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.980	.....	.....	.....	
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
0.104	0.105	0.007	0.007	0.007	0.007	0.010	0.010	0.004	0.004	0.370	0.370	.....	.....	1
0.463	0.467	0.636	0.642	0.761	0.772	0.215	0.218	0.103	0.104	0.172	0.172	0.224	0.224	2
51.66	52.14	43.84	44.25	42.70	43.33	41.17	41.71	51.30	51.65	59.61	59.64	59.36	59.48	3
9.97	10.06	22.87	23.08	21.25	21.56	20.03	20.29	9.68	9.75	5.71	5.71	7.81	7.83	1
0.36	0.36	0.54	0.54	0.27	0.27	.....	.....	.....	.....	7.51	7.51	0.99	0.99	2
73.18	73.86	61.93	62.51	60.64	61.54	58.69	59.46	73.28	73.78	76.36	76.40	83.69	83.87	3
2.35	2.37	1.78	1.80	3.71	3.79	6.71	6.80	2.43	2.45	4.22	4.22	1.97	1.97	4
0.56	0.57	0.05	0.05	0.19	0.19	0.62	0.63	0.15	0.15	0.11	0.11	0.32	0.32	5
.....	.....	.....	.....	.....	.....	0.32	0.32	2.84	2.86	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
0.22	0.22	0.13	0.13	0.04	0.04	0.17	0.17	0.07	0.07	0.46	0.46	0.86	0.86	8
0.12	0.12	0.05	0.05	0.26	0.26	0.09	0.09	0.22	0.22	1.38	1.38	1.34	1.34	9
0.205	0.207	0.013	0.013	0.013	0.013	0.019	0.019	0.008	0.008	0.694	0.694	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
0.37	0.37	0.35	0.35	0.16	0.16	.....	.....	.....	.....	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15
0.16	0.16	0.02	0.02	0.21	0.21	.....	.....	0.14	0.14	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
0.02	0.02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
0.18	0.18	0.14	0.14	0.06	0.06	.....	.....	.....	.....	.....	.....	.....	.....	22
.....	.....	.....	.....	0.03	0.03	.....	.....	.....	.....	.....	.....	.....	.....	23
0.07	0.07	0.07	0.07	0.11	0.11	0.14	0.14	0.07	0.07	0.16	0.16	0.41	0.41	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
1.060	1.070	1.456	1.470	1.742	1.768	0.498	0.504	0.237	0.239	0.396	0.396	0.512	0.513	26
.....	.....	.....	.....	.....	.....	Trace.	Trace.	Trace.	Trace.	.....	.....	.....	.....	27
0.07	0.07	0.06	0.06	0.06	0.06	.....	.....	0.15	0.15	0.12	0.12	.....	.....	28
0.91	.....	0.93	.....	1.46	.....	1.27	.....	0.67	.....	0.05	.....	0.21	.....	29
10.51	10.60	9.54	9.63	9.55	9.69	11.28	11.41	9.89	9.95	2.90	2.90	1.95	1.95	30
100.315	100.307	99.929	99.913	99.755	99.751	99.837	99.833	99.835	99.837	100.070	100.060	100.062	100.053	
11.64	11.75*	23.64	23.86	23.33	23.68	25.15	25.48	11.18	11.26	6.28	6.28	8.05	8.07	
9.97	10.06	22.87	23.08	21.25	21.56	20.03	20.29	9.68	9.75	5.71	5.71	7.81	7.83	1
1.36*	1.37*	0.62*	0.62*	1.81*	1.84*	5.05*	5.12*	1.38*	1.39*	0.50*	0.50*	0.21*	0.21*	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
0.02	0.02	0.01	0.01	0.03	0.03	0.10	0.10	0.07	0.07	0.04	0.04	0.05	0.05	4
0.10	0.10	0.05	0.05	0.13	0.13	0.02	0.02	0.10	0.10	0.01	0.01	.....	.....	5
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
0.18	0.18	0.14	0.14	0.06	0.06	.....	.....	.....	.....	.....	.....	.....	.....	9
.....	.....	.....	.....	0.03	0.03	.....	.....	.....	.....	.....	.....	.....	.....	10
.....	.....	.....	.....	.....	.....	.....	.....	0.20	0.20	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
.....	.....	.....	.....	.....	.....	.....	.....	Trace.	Trace.	.....	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14
11.[illegible]	11.73	23.69	23.90	23.31	23.65	25.20	25.53	11.25	11.33	6.26	6.26	8.07	8.00	

* With trace of oxide of iron.

THE COALS

OF THE

UNITED STATES.

THE COALS OF THE UNITED STATES.

By Frederick Prime, Jr., Ph. D.

The coal areas of Carboniferous age in the United States are five in number. They are—

The Massachusetts-Rhode Island area, comprising approximately 500 square miles;

The Alleghany area, about 59,000 square miles;

The Michigan area, about 6,700 square miles; c

The Illinois, Indiana, and West Kentucky area, about 47,000 square miles; and

The Iowa, Missouri, Kansas, Arkansas, and Texas area, about 78,000 square miles;

Forming a total of about 191,200 square miles, underlaid by coal-bearing strata, of which not over 120,000 square miles contain workable coal-beds.

Two general classes of coal are recognized, viz, anthracite and bituminous, the latter being often subdivided into bituminous and semi-bituminous coal.

Anthracite forms the whole of the coal found in the Massachusetts-Rhode Island area and in that portion of Pennsylvania occurring in the neighborhood of Pottsville, Mahanoy City, Shamokin, Hazleton, Mauch Chunk, Wilkes-Barre, and Scranton. It also occurs to a limited extent in Virginia. d

Bituminous coal occupies the rest of the districts just named.

A glance on a map of the coal-fields shows how unequally the coal areas are distributed over the United States. While New England and the seaboard Atlantic states contain practically no coal, the greatest development of the workable coal strata is in the Alleghany mountains and to the west of them, extending from Pennsylvania and Ohio in an unbroken line to Alabama.

Next to the one just mentioned the most important field is the one occurring in Illinois, Indiana, and western Kentucky. The coal area which extends from Iowa to Texas is of much less importance and extent, and the Michigan coal-field has scarcely been opened.

Let us now consider these different areas a little more in detail.

(I) The Massachusetts-Rhode Island area.—The coal is confined to eastern Rhode Island and Bristol and Plymouth counties in Massachusetts. At present the only mine worked is at Portsmouth, Rhode Island, where e one of the three beds found is being exploited. The coal-beds in this area seem to vary from 1 to 13 in number, but the explorations made in the past have been so unsystematic and, pecuniarily, so unsatisfactory, that the data on which these views are founded are not very reliable. The character of the coal is the hardest kind of anthracite, often containing spangles and plates of graphite disseminated through it, which characteristics are due to the highly metamorphic action it has undergone. To this same action is due in a great measure the peculiarly folded character of the deposits, which has locally caused expansions and contractions of the coal-beds, so that in some places they are 13 feet thick, and in others but a few inches. Such an irregularity renders the cost of mining the coal very great, owing to the large amount of "dead-work" required, and to this cause may in part be ascribed the slight progress which has been made in the development of the region. The working is now confined to a single mine.

Another potent cause for slight progress in development of this region has been the extreme hardness of the f anthracite. The extreme metamorphism which the coal has undergone has expelled the whole of the volatile ingredients and converted a portion of the carbon to graphite. It requires a very considerable degree of heat to burn this coal, and hence either a strong draft or blast is requisite. At present the use of the coal is confined to copper-smelting. The disadvantages in the exploiting and using the anthracite of this region are the more to be regretted, as it is situated in a district where its profitable extraction would be of the greatest use to other industries. All around it are large manufactories, and but a short distance off are valuable deposits of iron ore, all of which have to utilize either wood, anthracite from Pennsylvania, or bituminous coal from Nova Scotia, Pennsylvania, and Maryland. While the coal of this field is lying unused in the ground, that from other districts is brought hundreds of miles to be burnt directly over it. It is greatly to be desired that some means of successfully exploiting and burning the coal of this area shall be found.

a II. THE ALLEGHANY AREA, the most important in the United States in its extent in the number of workable coal-beds and in the quality and variety of the coals found, is situated in Pennsylvania, Ohio, West Virginia, Virginia, eastern Kentucky, East Tennessee, and northern Alabama. This area is divided into numerous different fields, more or less contiguous to one another, and of which a brief mention follows:

1. *The anthracite coal fields of eastern Pennsylvania.*—These anthracite fields are confined to a limited area of not over 475 square miles, situated in the counties of Carbon, Schuylkill, Northumberland, Columbia, Dauphin, Luzerne, and Lackawanna. Three districts are commonly recognized in this region, known as the first, second, and third coal-fields. The Coal Measures within this region are almost universally surrounded by two mountain-ridges, the exterior one consisting of sub-Carboniferous sandstone. This is separated from the interior ridge by a valley, more b or less broad, of easily decomposing red shale, overlying which occurs the true conglomerate, holding in its bosom the valleys or basins in which the anthracite occurs. These two series of ridges were the efficient protectors of the coal from the denuding agents, which removed it from the intervening barren districts, separating the different anthracite basins from each other and from the bituminous coal-fields of central Pennsylvania.

In the first, southern or Schuylkill coal-field, fifteen coal-beds have been recognized, varying from 2 to 25 feet in thickness, the total thickness of the coal being 113 feet, 80 of which are in workable beds.

The second or middle coal-field includes the Shamokin, Mahanoy, and Lehigh basins, the latter having Hazleton as its focus. These names must only be taken in a general sense, as in reality each basin is subdivided into two or more smaller ones, which must be passed by for lack of space. In these basins the principal coal-beds c are the Buck mountain, Wharton, and Mammoth or Big Vein. The latter is often over 29 feet thick and the Buck mountain over 15 feet thick.

In the third, northern or Wilkes-Barre basin, there are about twenty beds, the coals being divided into two groups, similar to those described in the bituminous coal area of Pennsylvania. The lower group, while containing some ten independent beds, rarely contains more than five fit for profitable working, in many places but two or three. The upper group, while containing seven or eight beds, never contains more than four which are worked, and the number is often less. The upper coal group is very circumscribed, being confined to a short and narrow elliptical belt in the very central tracts of the coal-field.

While the Alleghany coal area shows in a marked way the increase in the gaseous constituents of its coals, on passing westward, so, too, a decided change can be recognized on a smaller scale in the anthracite coal-fields. The d most easterly field contains the hardest variety of the anthracite, and the most westerly contains the softest or that least metamorphosed. The coal from the Wilkes-Barre region appears to be best adapted of all the anthracite for steam-raising purposes; that from the Lehigh basins seems best adapted to the manufacture of pig-iron, and of gas, and for foundery use; that from the Mahanoy, Shamokin, and Schuylkill fields seems best adapted to domestic use, although more wasteful than either of the other. It is, however, difficult to specify the advantages of the coals from one of the anthracite basins over those from another, the peculiar properties claimed for some special variety being often due to the fact that the proprietors of some colliery have had peculiar advantages, and hence claim or imagine some special advantage which often does not exist. The great advantages in burning anthracite are cleanliness, lack of smoke, compactness, rapidity with which steam can be raised, concentration of great heating power, adaptability for household use, and in some varieties great purity for iron-making. On the other hand, a e considerable quantity of the fuel must be aggregated in order to produce combustion.

Another great advantage of the anthracite of Pennsylvania is its favorable situation to many important industries. All of the coal-basins are tapped by two or more railroads which carry the coal directly, by favorable grades, to the two cities of New York and Philadelphia, whence the coal is distributed by water transportation to the various important industries of New England, New York, New Jersey, Pennsylvania, and Delaware. Other railroads carry the coal by grades, not quite so favorable, to lakes Erie and Ontario, whence it is distributed to the various great cities of the west and Canada.

2. North of the anthracite coal-fields proper is the semi-anthracite of the *Bernice basin* in Sullivan county, Pennsylvania, where the principal coal-bed, 8 to 9 feet thick, contains 8 to 9 per cent. volatile matter. The coal, while classed as an anthracite, lacks the brilliant anthracitic luster and conchoidal fracture, generally breaking f in cubes; in composition it closely resembles the semi-anthracite of Lykens valley, in Dauphin county. The whole of this coal is carried north and west, for distribution and consumption.

3. *The Broad Top coal-field of Pennsylvania.*—The coals of this basin, which occupies about 25 square miles, all belong to the Lower Productive Coal Measures, of which more presently, with the exception of a few acres of coal of the Pittsburgh bed. The measures in this coal-field have been much disturbed, so that the relations of the strata are not fully understood, and consequently frequent errors have been made in identifying the coal in different portions of the district. There are apparently three workable beds. The coal of this district, while actually bituminous in character, is commonly called semi-bituminous on account of the comparatively small amount of volatile matter it contains, often as low as 8 per cent. At one time the mines of this district were actively worked, the coal being used for steam-raising and rolling-mill purposes. Since the opening of the Clearfield coal-district and the more active exploitation of the Cumberland coal-beds, the mining interests of this district have languished,

owing in part to an inferiority in quality of this coal to either of the others; in part to the greater cost of extraction, a due to the more disturbed condition of the strata.

4. *The bituminous coal-fields of Pennsylvania.*—While the bituminous coal-fields of Pennsylvania are contiguous to those of Ohio and West Virginia, the latter being actually but extensions of the former, they are, for the sake of description, separated geographically.

In the bituminous coal area of Pennsylvania, Ohio, and West Virginia geologists and engineers have recognized (1) Upper Barren Measures; (2) Upper Productive Coal Measures; (3) Lower Barren Measures; (4) Lower Productive Coal Measures; (5) Inter-conglomerate coals.

The Washington coal-bed occurs in the Upper Barren Measures, and can only be profitably mined in Pennsylvania in Washington county. b

The following coal strata occur in the Upper Productive Coal Measures, commencing with the upper bed: Waynesburg coal-bed, Sewickley coal-bed, Redstone coal-bed, Pittsburgh coal-bed. Of these the Pittsburgh is of far the greatest economical value, but the others are locally of importance.

In the Lower Barren Measures are a few beds which are most uncertain in character and of but little economical value; they are most unreliable in character, and while locally they thicken so as to be of some local value, they speedily thin out again.

Below the Lower Barren Measures are found the following coal strata, viz: Upper Freeport coal-bed, Lower Freeport coal-bed, Upper Kittanning coal-bed, Lower Kittanning coal-bed, Clarion coal-bed, and Brookville coal-bed.

Still lower, geologically, are the coals occurring in the Great Conglomerate, which include the Clarion group, c the Quakertown bed of Lawrence county, and the Sharon bed of Mercer county. These coals occur in six different basins, of which the sixth is the most southwesterly in position and least distinct as to its division. Each basin is separated from its neighbor by an anticlinal wave, or rather by a series of separate anticlinals, the ends of which lap past each other.

Having the Alleghany mountains as an eastern barrier, the coal-fields extend westwardly in a more or less unbroken succession into Ohio. But the coal-beds are by no means equally distributed over this area. As middle Pennsylvania and middle New York were lifted, by geological action, much higher above the old sea-level than southwestern Pennsylvania, Ohio, and Virginia were, the destruction of the coal measures has been greatest in the north and northeast, gradually diminishing toward the southwest. Only the lowest, or two or three lowest, beds of coal have been left as isolated patches on the mountain tops of Wyoming, Sullivan, Lycoming, Clinton, Bradford, d Tioga, Potter, Cameron, McKean, and Warren counties.

The great productive bituminous coal-field may be said to commence in the belt of counties composed of Clearfield, Jefferson, Clarion, Venango, and Mercer counties, a distance of 140 miles to the Ohio line from the crest of the Alleghanies. In the counties last mentioned, as well as in Cambria, Indiana, Armstrong, Butler, Lawrence, Beaver, Somerset (with the exception of the Salisbury patch), eastern Westmoreland, and eastern Fayette, only the Lower Productive coal-beds, and in places the inter-conglomerate coals have been left, while the Upper Productive Measures have been swept away. These latter are found in great part with all the Lower Productive Coal Measures in Alleghany, western Westmoreland, and western Fayette counties, while the whole of the Upper and Lower Productive Measures occur in Washington and Greene counties. In brief, the Coal Measures are most eroded toward the northeast, and are least disturbed toward the southwest. e

We will now consider the different coal-beds mentioned a little more fully.

The Washington coal-bed is only found of workable thickness in Washington county, where it is 10 feet thick; where found elsewhere in Pennsylvania it is too thin to be profitably mined. It occurs in the Upper Barren Measures and about 140 feet above the bottom of these.

About 150 feet below the Washington bed occurs the Waynesburg main coal, from 6 inches to 10 feet thick. It is the chief source of coal supply in Greene county, and is also mined in eastern Washington county, but grows thin and poor towards the west. It is commonly a triple bed, but sometimes has but two benches, and is occasionally much split up.

The Sewickley coal-bed lies about 270 feet below the Waynesburg bed. It occupies about the same area in the four southwestern counties of Pennsylvania as the Pittsburgh bed, but the isolated hills in Alleghany, Beaver, f and Indiana counties, which contain the Pittsburgh, are rarely high enough to reach the Sewickley. It occupies a narrow strip of the Salisbury basin in Somerset county, where it is thin and only 90 feet above the Pittsburgh bed. West of the Monongahela river it is only of importance in the southeastern portion of Greene county, being found 5½ feet thick on Dunkard's creek and in two benches. In the Blairsville-Connellsville basin it is usually workable, and becomes 5 feet thick south of the Youghiogheny, thinning down northward almost to nothing on crossing the Loyalhanna. It is thin and poor in the Greensburg basin, and in the Lisbon basin loses its size and value north of Sewickley creek.

The Redstone coal bed lies between the Sewickley and Pittsburgh beds. It is coextensive with the latter, except in the isolated hill tops north and east of Pittsburgh too low to contain it. On the Monongahela it overlies the Pittsburgh bed about 60 feet, varying from 1 to 4 feet in thickness. In Westmoreland and Fayette counties it varies from 2 to 4 feet in thickness, being a good workable bed along the Youghiogheny river and

a Sewickley creek. Along the Pennsylvania railroad it is 1 foot to 3 feet thick. In the Connellsville basin the Redstone bed is very variable, being in some places but 6 inches thick, in others 4 feet thick. In the Salisbury basin it is 4 to 5 feet thick, and about 45 feet above the Pittsburgh bed.

The Pittsburgh bed "is the principal coal-bed of southwestern Pennsylvania; and most of the mineral fuel which is mined along the Youghiogheny and Monongahela rivers, to be used in the coke-ovens of the Connellsville region and in the blast-furnaces, mills, and factories of Pittsburgh and its vicinity, and to be shipped to southern and western markets, comes from this bed. The Pittsburgh bed underlies all Greene county and nearly all of Washington county, and long synclinal areas in Westmoreland and Fayette counties, west of Chestnut ridge. Outlying patches of it occupy the hill-tops in Allegheny and Indiana counties, and there is a small patch of it in Somerset county. b From all the rest of the state the bed has been removed by erosion; but there is good reason for believing that it formerly extended beyond the Susquehanna river, and that it has been preserved as one of the beds of the anthracite basins of eastern Pennsylvania" (the Mammoth or Big bed). It is 11 to 12 feet thick at Connellsville, while but 6 to 7 feet thick in the hills around Pittsburgh. "This bed is best developed in the Connellsville trough, between the Conemaugh river at Blairsville and the mouth of the Cheat river at the Maryland state line. It becomes thinner westward, and, after passing Pittsburgh and descending the Ohio river toward the Ohio state line, it loses almost all its value as a source of fuel." This coal varies very greatly in character, so that good shipping coal can only be got from the Lisbon, Waynesburg, and Nineveh troughs, and along the Youghiogheny and Monongahela rivers. While it is too soft to bear much handling in the Greensburg and Blairsville basins and near the Maryland state line, c and contains less volatile combustible matter than that from the more western basins, it is not so well adapted to the manufacture of gas, but it makes a most excellent coke, which has no superior in this country. In the Lisbon or Irwin trough it is a most excellent gas-coal, and is shipped great distances to be used for the manufacture of gas. The coal from the northern portion of the Irwin trough is unexcelled for raising steam, and is shipped for this purpose from Westmoreland county to Jersey City to be so employed. In the district described the Pittsburgh bed is always found as a most excellent coking coal; in same places it is slaty and has first to be washed. In others it is too rich in gas to permit the lump-coal to be economically used for this purpose. The coke made from this coal is unrivaled in the United States, especially for blast-furnace use, as it is tough and strong and will stand well in the highest furnaces without crushing. The coke basin, as generally understood, is co-extensive with the Blairsville trough, but the coke made varies greatly. That made on the Youghiogheny is compact, silvery, d and retains its luster indefinitely on exposure, while that made near the Conemaugh is comparatively tender, dull-looking, and soon loses its luster unless the coal is washed. If the latter be done the coke produced is equal in quality to that made on the Youghiogheny. The coke made is all produced in beehive ovens.

The Upper Freeport coal-bed, which is about 600 to 700 feet below the Pittsburgh bed, is the top bed of the Lower Productive Measures. It underlies, generally at great depths, the whole of Pennsylvania south of the Ohio and west of the Monongahela rivers. It is also found in Westmoreland, Fayette, Indiana, Armstrong, Allegheny, Beaver, Lawrence, Clarion, Cambria, Clearfield, and Jefferson counties. It is a good coal, of 4 to 6 feet in thickness, over extensive districts, being best adapted, when washed, to coking and to steam-raising; but there are extensive districts where it is utterly valueless.

The Lower Freeport coal bed lies from 30 to 70 feet below the Upper Freeport bed. It has been developed but e locally, and is not of great economic value.

The Upper Kittanning coal-bed is locally of value, as at Darlington, in Beaver county, and in Jefferson county, where it is overlaid by 8 to 12 feet of cannel coal. In Jefferson county it attains 10 to 12 feet in thickness and rivals the Pittsburgh bed as a gas-coal. It lies from 50 to 80 feet below the Lower Freeport coal.

The Lower Kittanning coal-bed is mined but locally.

The Clarion coal-bed is that extensively worked in Clearfield county, and which gives the celebrated steam-coal which comes into competition along the Atlantic seaboard with that raised in the Cumberland region of Maryland. For steam-raising and rolling-mill work it is unexcelled, except by portions of the Pittsburgh coal.

The Brookville coal-bed is generally too thin and full of sulphur to be mined. This is the lowest coal above the great conglomerate.

f Among the inter-conglomerate coals are the so-called Clarion group, whose identification is not yet complete. They occur at Fall Brook, Tioga county, and are there of considerable value. The other inter-conglomerate coals are of little value in Pennsylvania.

The coals of the bituminous region of Pennsylvania are almost entirely dependent on the Pennsylvania and the Baltimore and Ohio railroads and their controlled lines for outlets to markets. In many cases the distances which the coals have to be carried before reaching a market are very great, and the freights paid amount to double or treble the cost of the coal. This is a very great disadvantage, when compared with the short distances coals are hauled in Europe, and greatly enhances the cost of our manufactures. Except for markets along the Ohio river and great lakes the bituminous coals of Pennsylvania are at a great disadvantage when compared with the anthracites. Fortunately a large proportion of them is locally consumed in manufacturing industries; while the gas-coals are of such a value that they will bear transportation at high prices.

5. *The coal-fields of Ohio.*—The Ohio coal-fields are but the western extension of the bituminous coal-region of Pennsylvania, consequently the coal-beds which are found in them are the same, with local modifications, as those

of the latter state. Commencing at the Pennsylvania-Ohio line we find that "the margin of the coal-basin forms a a tortuous line commencing in the northern part of Trumbull county, passing thence southwesterly to the Mahoning valley, where it is deflected far to the southeast. West of Youngstown it runs through the southern townships of Trumbull county, where it is deflected north nearly to the center of Geauga county, where it incloses a long tongue, and two or three small islands of coal. Thence returning into Portage, it passes southeasterly through the southern part of Summit, where it is deflected to the northwest. From here it runs southwesterly again to the southwest corner of Holmes. Thence it passes nearly southward along the western margin of Holmes and Coshocton; thence southwesterly through the eastern part of Licking. From here its course for 50 miles is nearly south to the center of Hocking, where it turns slightly westward, and passes through Vinton, Jackson, Pike, and Scioto to the Ohio, where it crosses" into Kentucky. The counties more or less underlaid by coal in Ohio are Mahoning, Columbiana, b Portage, Stark, Holmes, Carroll, Tuscarawas, Jefferson, Harrison, Belmont, Guernsey, Coshocton, Muskingum, Perry, Noble, Morgan, Washington, Monroe, Meigs, Athens, Jackson, Gallia, Lawrence, Trumbull, Summit, Medina, Wayne, Licking, Hocking, Pike, and Scioto.

Thirteen coal-beds have been recognized in Ohio, and the geologists who have there given them numbers, call the top bed No. XIII. Of these beds Nos. I to VII belong to the Lower Productive Measures, and Nos. VIII to XIII to the Upper Productive Measures. No reliable coal-beds have been found in the Lower Barren Measures.

Coal-bed No. XIII, which is the Washington bed of Pennsylvania, is limited to Belmont county, and is of no practical value.

Coal No. XII is sometimes 6 feet thick in the highlands of the Ohio river opposite Wheeling, but is so heavily c charged with pyrite as not to be mined except for local use.

Coal No. XI, known locally as the "Jumping 6-foot seam", is the equivalent of the Waynesburg coal of Pennsylvania. It is locally of some value in Belmont county, but is very unreliable both in quality and in thickness. Within 100 yards it varies from 6 inches to nearly 6 feet. It is rarely of any economical value, and nowhere yields good coal. In Jefferson and Harrison it is found in the highest hill-tops, but is never more than 2 feet thick.

Coal No. X is a more persistent bed than the preceding, and has been traced in Belmont, Harrison, and Jefferson counties, but in all of these is of far less value than the Pittsburgh bed. It is mined extensively in parts of the counties mentioned to supply local demand. At the west it is rarely less than 4 feet thick, but rapidly thins out until it has entirely disappeared at the Ohio river. d

Coal No. IX, which occurs in Belmont, Jefferson, and Harrison counties, is from 18 to 30 inches thick and of no value. In places it has been let down upon the Pittsburgh coal.

Coals Nos. VIII*b* and VIII*c*, which are supposed to be the equivalents of the Sewickley bed, are of no value.

Indeed, all the coals of the Upper Productive Measures in Ohio, except VIII, of which more anon, are of but little value.

Coal No. VIII, which is the equivalent of the Pittsburgh bed, enters Ohio in Jefferson county. In Ohio it is commonly known as the Pomeroy bed. From Jefferson it outcrops in Muskingum, Morgan, Athens, and Meigs counties, underlying all the counties to the southeast of these, and crosses the Ohio into West Virginia at Pomeroy. This coal-seam, which is one of the most important beds in Ohio, is an excellent coking coal, generally somewhat more sulphury than in Pennsylvania, but locally quite free from this. While in some localities quite thin, in e Morgan, Athens, and Meigs counties it varies from 5 to 9 feet in thickness, and is often divided into one or more benches. Where mined in Meigs county it is much liked as a steam- and mill-coal.

While the coal-beds of the Lower Barren Measures of Ohio are generally of little importance, there is one bed which is quite persistent, known to Ohio geologists as coal No. VII; it is a very variable coal. In Tuscarawas, Coshocton, Holmes, and Stark counties, lying about 100 feet above coal No. VI, it is valuable as being associated with black band ore and locally, also, with limestone. In the counties named the bed is 1½ to 3 feet thick, soft and sulphurous, and only valuable for calcining the iron ore. In the eastern part of Carroll and in Jefferson county it is 3 to 4 feet thick and of a much better quality, as at Salineville. In southern Carroll and the adjoining portions of Harrison it is 4 or 5 feet thick, and of fair quality. It is the "Cambridge" coal of Guernsey county, and the "Alexander" coal of Muskingum county, at the latter point being 6 feet thick, and of fair quality. This f same bed is called the "Sheridan" or "Bayley's Run" in Athens county, where it is 4½ to 5 feet thick, and is extensively worked. Next to the Straightsville (No. VI) or Nelsonville bed it is the most important coal in this section of Ohio. It is a coking coal, generally containing more sulphur than bed No. VI, but in places is pure enough to make an excellent coke. It extends south through Jackson, Gallia, and Lawrence counties to the Ohio.

The coals of the Lower Productive Measures in Ohio are of much greater value than those just briefly enumerated. In a descending series, the first coal-bed met with is—

Coal No. VI, or the Upper Freeport coal of Pennsylvania. This is the most important coal-bed in the state, as being thicker, occupying a greater area, and supplying a greater amount of valuable fuel than any other. In northern Ohio it is a rather soft coking coal, containing a moderate amount of sulphur, but too much to be used in gas manufacture. But it makes an excellent coke if washed. It occurs almost everywhere in Holmes county, being 3 to 6 feet thick, and is the fuel most in use. In Tuscarawas county it is of the same character as in Holmes, being 4 to 7 feet thick. In Stark county it is 4 to 6 feet thick in the neighborhood of Osnaburgh and Mapleton, but thence

a southward loses its thickness and its importance. Crossing into Columbiana county it stretches continuously through the highlands of the water-shed to the Pennsylvania line. At Salineville and elsewhere it ranges from 5 to 7 feet, but is not so pure as farther west. Just above Steubenville it dips below the Ohio. It is here 4 feet thick, a partially open-burning coal of great excellence. It is used both raw and coked for iron-smelting, being now generally coked. At Rush run it is 7 to 8 feet thick, but not so pure. In the eastern part of Columbiana county it is purer, and at the Sterling colliery it is mined as a gas coal. In Coshocton county it is in places harder and purer than farther north, and if rightly prepared would make an excellent coke. South of the National road it acquires a much greater magnitude. While in Muskingum county it has the same property as in Holmes, and is not so thick and pure as in Coshocton, it acquires its greatest importance in Perry, Hocking, and Athens counties.
b In this district, known as the Hocking Valley region, the coal attains a thickness of 4 to 13 feet. The coal which is locally known as the Straightsville or Nelsonville coal becomes here very hard and dry burning; it swells but slightly in the fire, and is in some places very free from sulphur, while in others it contains too high a percentage to be used in iron-smelting. Where best developed it is almost as compact and homogeneous as anthracite, and after the volatile matter is driven off leaves a mass of glowing coals resembling an anthracite fire. In places it resembles a cannel coal, again in others is a splint coal; occasionally it is sufficiently pure to be sold as a gas coal; nor is it excelled by any coal in the state as a domestic fuel. In the Mahoning region this coal is apparently very variable in quality, and as a consequence great care should be taken in testing its character. South of Athens county coal No. VI has not been certainly recognized; if it exists it is much diminished in thickness and value on
c its western outcrop.

Coal No. V is the equivalent of the Lower Freeport coal of Pennsylvania. In Tuscarawas county it is mined at Mineral Point, being an open-burning coal of good quality, 4 feet thick. It is generally mined in the southern and eastern townships of Stark county, but is only 30 inches thick. At Alliance, while 4 feet thick, it is softer and more sulphurous. It does not seem to have been tested as to quality elsewhere in Ohio.

Coal No. IV is the Upper Kittanning coal of Pennsylvania. It is of very variable character and but little mined for more than local use, except at Leetonia, in Columbiana county. Here it is a very pure coal, and at Canfield and Darlington it is a cannel coal. In some parts of the state it is an open burning coal; in others a cannel, as in Coshocton county. In thickness it varies from 2 to 6 feet.

Coal No. III is the equivalent of the Lower Kittanning coal of Pennsylvania. It is a very variable bed,
d exhibiting marked changes of thickness within limited areas. Near the eastern border of the state it is a coking coal, 2 to 4 feet thick, and contains considerable sulphur. It is extensively worked at New Lisbon, Columbiana county, and is coked there. It is mined in the southwestern corner of Stark county, where it is 3½ feet thick, partially open-burning, and of excellent quality. In Holmes county it becomes a cannel in places where it is 5 feet or more thick.

Coal No. II is of no economic importance.

Coal No. I is probably the equivalent of the Brookville coal of Pennsylvania.

In Ohio this is the lowest coal bed of the series, usually 20 to 25 feet above the Great Conglomerate. It is best known in the state as the Briar Hill, Mahoning Valley, Massillon, or Jackson coal. With the exception of Coal No. VI, it is the most valuable seam in the state, from the fact that in many localities it is of good thickness, of remarkable purity, and well adapted in the raw state to the smelting
e of iron ores. It is a typical furnace coal, and forms the fuel by which fully one-half the iron produced in Ohio is manufactured. Unfortunately it is an exceedingly irregular seam.

Its best development is in the Mahoning valley. It is here very compact, working in large blocks, from which fact it has received the name of block-coal. It is mined at Palmyra, in Portage county. It is largely mined in Wayne, Summit, and Stark counties, having been extensively worked for years, a large amount being sent to Cleveland, as well as for iron-making and other manufacturing purposes at home.

In Summit and Stark counties this coal is generally more bituminous than in the Mahoning valley, and has less of the block character. While less pure than in the latter locality, it is still a very pure and highly esteemed coal. It is used in the raw state in the furnaces of the neighborhood with satisfactory results; but from its inflammable character its combustion is not quite so easily regulated as that of the Mahoning valley. As a household coal it has no superior, and is preferred by those who use it to every other variety, even to the best cannel.

f From Massillon to the Ohio, along its line of outcrop, it is, as a rule, of little importance, being commonly thin, of inferior quality, and often absent. It is mined a little in Holmes county, but south of this is of no value until reaching Jackson county. Here it is 4½ feet thick, pure, much resembling the Mahoning Valley coal, and is extensively mined and used as a furnace-coal.

With the exception of the coal of the Mahoning and Hocking valleys, none of the Ohio coals will be extensively transported except for domestic use. The two coals named will be transported some distance to be used in manufacturing, where they occur of a sufficient degree of purity. What is needed in many parts of the state are better railroad facilities for the transportation of these coals. It is not likely that the No. VIII coal will be extensively mined along the Ohio river for transportation for years to come, as it does not equal in quality the same (Pittsburgh) coal from Pennsylvania, which can be floated down the river at a low cost. Still, the coal industry in Ohio is but in its infancy.

6. *The coal-fields of West Virginia and Virginia.*—No state in the Union surpasses West Virginia in the variety of coals it contains, nor does any contain an equal amount in proportion to its area, for of the fifty-four counties in

the state but six are entirely destitute of this important fuel. In many of them, however, the coal is so deeply a buried, and in others the means of transportation are so inadequate, that it will be many years before the mineral wealth they contain will even commence to be developed. In Virginia, on the other hand, there are but six counties which contain coal of Carboniferous age, and they are in the extreme southwestern corner of the state, adjoining West Virginia and Kentucky. The coal-field of West Virginia and Virginia is but an extension of the Appalachian coal-field from Pennsylvania, Maryland, and Ohio, and the general system of the measures is the same, with the exception that locally some of the coal-beds in the Great Conglomerate are of a sufficient thickness to be profitably worked. The great drawback to the development of this coal-field at present is a lack of transportation facilities; consequently, except at points hereafter mentioned, the coal-seams have only been slightly developed for local use, and their thickness and value are not fully known. West Virginia has two markets for its coals—one is that of b the Atlantic sea-board states, which are reached by the Baltimore and Ohio and Chesapeake and Ohio railroads; the other is that of the Mississippi valley. From the eastern margin of the coal-field the strata have a general inclination to the northwest, so that on leaving the Alleghanies the rocks belonging to the formations below the coal disappear, and the Coal Measures themselves become buried and are succeeded by the Upper Barren Measures on approaching the Ohio. The Coal Measures in Ohio form the other half of this geo-synclinal trough or basin, in which the Ohio river flows the greater part of its course, a little to the west of the center line of this basin.

The eastern and western margins of this trough gradually approach each other as they extend northward, and bending around—the former in Pennsylvania and the latter in Ohio—at length meet and form the northern termination of the basin. Fortunately for the counties of West Virginia forming the so-called "Pan-Handle", this northern c termination occurs at no great distance, so that the Ohio in its western course along the margin of the Pan-Handle intersects the southerly dipping coal-beds in a direction highly favorable for the development of their rich mineral contents. In fact it does still better, as it cuts the successive coal strata along the whole river-front, for, beginning at the northern extremity of the state near the mouth of the Little Beaver, the Ohio river flows in the lower part of the Lower Coal Measures, which crops out farther north. Descending the river, the inclination of the rocks being toward the south, the lower coals pass below the river-bed, and at the top of the hills opposite Steubenville the lowest coal-bed of the Upper Coal Measures (the Pittsburgh bed) appears; this descends slowly, until it also disappears, a short distance below Wheeling.

The superior strata come lower and lower, till Fishing creek, in Wetzel county, is reached. Below this point, flowing more toward the west, it is west of and parallel to the axis of the Appalachian basin, still exposing only the d upper strata, but bending northwest. Near Marietta the river displays lower formations, in which it continues until reaching Parkersburg. By a series of flexures it works back into higher strata till it reaches Jackson county, when by a sudden turn it penetrates into the western side of the basin, and the rocks dipping southeast, the strata, which were buried below its bed, gradually emerge to the surface, thus bringing to light the Pittsburgh bed, worked at Pomeroy, which had disappeared just below Wheeling. It continues to expose nearly the same beds until reaching Guyandotte. Then bending west, it enters the Lower Coal Measures about 3 miles above the Big Sandy, which measures have been buried since leaving Brooke county, in the northern part of the state, and finally emerges from the Coal Measures near Portsmouth.

The Coal Measures of the New and Kanawha rivers are those which have been most widely explored and e extensively mined. In Mercer county are extensive coal-beds, which seem to belong to the sub-Conglomerate Measures, and are developed to a greater thickness than elsewhere in the state, but the developments have hitherto been too slight to accurately determine their precise geological position. At Quinnimont, in Raleigh county, two sub-Carboniferous coal-beds are worked in the Great Conglomerate—the lower one, 4 feet thick, supplies the Quinnimont furnace with fuel; the upper one has been but slightly developed, and seems to be 3 feet thick. The former of these two beds is a semi-bituminous coal, soft and friable, and makes a hard, silvery coke of excellent quality. The coal is also well adapted for steam-raising purposes and household use, as it makes a very hot, red fire. Continuing down the New river, we find the Brookville bed of Pennsylvania, worked by various parties in Fayette county. It is here 3½ feet thick, is a tender, friable, semi-bituminous coal, yielding an excellent coke. Passing down toward and to the Kanawha river, this lower bed is succeeded by the other beds of the Lower Coal Measures, which yield all the varieties of bituminous coal, viz, semi-bituminous, bituminous, splint, and cannel. Nowhere is f a richer gas-coal found, and one which is more prized by the gas companies as an enricher for the leaner, cheaper coals, except in Kentucky. Properly washed, the coals when coked yield a product fully the equal in quality of that from the Connellsville region. Again, the splint coals are fully up to standard as steam- and furnace-coals, and are much liked for those purposes. The great advantage of the coals along this section is that they occur above water-level and can be mined by tunnels, without shafting and pumping. In the Monongahela basin the coals met with belong to the Lower and Upper Freeport, the Pittsburgh, the Redstone, the Sewickley, and the Waynesburg beds.

In Monongahela county the Lower Freeport seam is 4½ feet thick; the Pittsburgh, 11 feet; the Redstone, 5 feet; the Sewickley, 6 feet; and the Waynesburg, 5 to 6 feet. The Pittsburgh is the only bed worked to any extent, and here, as elsewhere throughout the state—except in the Potomac basin—is a valuable gas-coal and yields a

a good, firm, solid coke. At times, however, it is high in sulphur, which renders it unfit for iron-making purposes. The sulphur is not so detrimental for gas purposes, as it can be neutralized by lime, and the coal contains more gas than the Westmoreland coals of Pennsylvania.

In the Preston County basin are all the coals of the Lower Productive Measures, and in the southern end the hilltops contain the Pittsburgh bed. The only coal-bed worked is the Upper Freeport, which, while 8 to 9 feet thick, only affords 4 feet of good coal in its lower bench.

The Potomac basin is only a prolongation of the Maryland Cumberland basin. Here are all the coals of the Lower Productive Measures occur, as well as two beds of the Upper Productive Measures. The main bed is the Pittsburgh, which here attains a thickness of 14 feet, but the coal is so soft that not over 60 per cent. goes to b market. The coal is semi-bituminous in character, and contains but little gas. It is chiefly used for steam- and rolling-mill purposes. (*a*)

Finally we come to the coals of Virginia proper, which are confined to Tazewell, Russell, Scott, Lee, Buchanan, and Wise counties. The coals, but little developed hitherto, belong to the Lower Productive Measures. It is known that they will coke, and are sufficiently pure to make an excellent blast-furnace fuel. From the railroad developments now going on in that region it will not be long before these coals are utilized for iron-making purposes.

7. *The Maryland coal-field*, better known as the Cumberland coal-basin, is but a prolongation of the Potomac basin mentioned under West Virginia. This coal-field is one of the most important in the United States, due to the thickness of the main bed, its good quality, and the large annual production. The coal is most extensively c used for rolling-mill and steam-raising purposes, its chief and only competitor among the bituminous coals being that from the Clearfield region of Pennsylvania. This coal-field is an outlier of the main Alleghany coal area, of which there are several others in Pennsylvania, such as the Broad Top, Snowshoe, Ralston, and Blossburg basins. The coal is semi-bituminous in character, and does not coke quite so readily as those which contain more gas. Nowhere are the whole of the Coal Measures, both Upper and Lower Productive Measures, better displayed than they are here, but without the Upper Barren Measures. The best coals are those of the Upper Productive Measures, which occur here of full thickness, while those of the Lower Productive Measures are small, being split up into a large number of thin seams. The main bed is the Pittsburgh, which occurs here 14 feet thick. The whole of the coal is shipped, both coarse and fine, and sent to market. It is usually mined out in large lumps, but being unfortunately of a friable nature, it becomes much pulverized in handling and transporting.

d A great advantage of this coal field is its proximity to market, as it has the canal and two railroads by which the coal can be brought to the seaboard. The chief market is New York. While the Pittsburgh is the chief bed now mined, it will take but a few years to exhaust it owing to the enormous demand and the wasteful methods of mining which are in vogue. When this is done, recourse will necessarily be had to the overlying beds, which are much thinner. The Redstone is here 4½ feet thick, the Sewickley 3½ feet, the Waynesburgh 6 feet, and the Washington or Brownsville but 2 feet. The extent of this basin is small, the Pittsburgh bed having originally covered 27 square miles.

Turning from this small and important coal district, we come next to that portion of the Alleghany coal area included in eastern Kentucky.

8. *The eastern Kentucky coal-field* is but a continuation of that described in Ohio and West Virginia. The e western boundary of the Alleghany coal area in Kentucky is approximately as follows, in a north-south direction: Starting at the Ohio river near Tygart's creek, the line runs through Greenup, Carter, Rowan, Morgan, Powell, Estill, Jackson, Laurel, Pulaski, Wayne, and Clinton counties to the Tennessee line. This coal field underlies the whole of fifteen counties and a portion of five others, containing 8,983 square miles. The boundary line is very crooked, throwing off numerous spurs, extending west of the line mentioned. While two separate divisions of the

a Since the above was written development has shown that of the 14 feet thickness of the Pittsburgh seam 12 feet are excellent coal, high in fixed carbon and low in sulphur, as appears from the following analyses from differential samples taken by the writer and analysed by Dr. F. A. Gooch.

f

	Whole thickness mined 12 feet.	Bottom bench, *i. e.* lower 2 feet mined.
Water	0.19	0.26
Volatile combustible matter	19.98	20.56
Fixed carbon	71.77	72.39
Ash	8.06	6.79
	100.00	100.00
Sulphur	1.045	1.737

Sulphur in upper bench (10 feet) 0.891 per cent.

While the Pittsburgh bed is confined to the hill tops and covers a limited area south of Elk Garden, the whole basin is underlaid by a group of coal-beds corresponding apparently to the Kittanning and Clarion beds. One at least of these appears—1882—to be persistent as a workable bed from 6 to 9 feet thick with from 4 to 8 feet of fine bituminous coking coal, high in fixed carbon and low in sulphur and ash.—R. PUMPELLY.

coal strata can be observed, they differ from the northern portion of the Alleghany area in the fact that the coals **a** belonging to the Upper Productive Measures are wholly lacking. The Upper Coal Measures of Kentucky belong to the Lower Productive Measures farther north, while the lower coal-beds are inter-conglomerate coals, belonging to the Great Conglomerate. The Upper Measures of Kentucky are known to contain twelve coal-beds, while in the southeastern counties two, and possibly three beds occur in the conglomerate. These latter coals occur along the western margin of the coal-field, being at times 4 to 5 feet thick, but generally much thinner. Their remoteness from market and the presence of coal in thicker beds and much superior in quality, will probably confine their exploitation and development to the requirements of the neighboring population.

The general dip of the Coal Measures is about southeast, or at right angles to the trend of Pine mountain. This chain, ranging from the southern part of Whitley county in a northeast direction through Harlan county to the War gap, and thence to the Sounding gap, at the junction of Letcher and Pike counties, has been produced **b** by a dislocation of the Coal Measures, which has upheaved the sub-Carboniferous limestone more than 500 feet up into Pine mountain, thus dividing this coal-field by a vast fault into two basins, one on each side of the mountain.

Of the twelve beds belonging to the Lower Productive Measures, the lowest, or No. I, is the equivalent of the Brookville coal of Pennsylvania, and of the Brier Hill coal of Ohio. It varies in thickness, being at times too thin to be profitably mined, but it has, when developed, a local uniformity, which will permit of its being easily mined where sufficiently thick. Its thickness gradually increases from the Ohio, where it is 15 inches, to Warfield, in Martin county, where it is 5 feet. Toward the west, where it occurs in the hill tops, it generally thins out along the line of its outcrop. This bed varies in quality at different points, but is generally a splint or open-burning coal in character. It has not been tried in the blast-furnace, but is in places too high in sulphur to be adapted to iron-smelting in its raw state. Near the Ohio this coal is less reliable in quality than in Carter and Lawrence **c** counties.

Bed No. II (the Clarion coal-bed of Pennsylvania) is less important than bed No. I. It covers a wide extent of country, and is in places of good quality and thick enough to mine. It varies from 2 to 3½ feet in thickness, and is locally mined for domestic use.

Bed No. III (the Lower Kittanning bed of Pennsylvania) varies from 3 to 6 feet in thickness, the latter being at Peach Orchard, on the Big Sandy river. Usually the coal is a bituminous one, but at times it contains a layer of cannel coal.

Bed No. IV (which may be the equivalent of the Upper Kittanning of Pennsylvania, but is probably only a local coal) is a cannel coal, portions of the bed being bituminous. It is known in the market as "Hunnewell cannel". The bed is 2½ to 5 feet thick, but it seems to be entirely wanting in places, as in Lawrence county. The **d** amount of volatile matter in this cannel coal is remarkable (66 per cent.), while the fixed carbon is very small (28 per cent.). Consequently it is a valuable coal for gas-making purposes.

Bed No. V is locally known as the Pennington and Cooksie Fork coal, its greatest development being in Lawrence and Carter counties. It is only mined at Buena Vista furnace, where it is 3½ feet thick, and of good quality. The general character of the coal is unknown, owing to lack of developments.

Bed No. VI is locally known as the Keys Creek or River Hill coal, and has its greatest development in Boyd county. Where mined, at Louisa, in Lawrence county, it is a little over 2 feet thick and a good quality of bituminous coal. It is also found in Boyd county, but is less reliable, both in quality and thickness.

Bed No. VII is widely known as the Coalton coal. It is extensively mined at Coalton and a number of other points on the eastern division of the Lexington and Big Sandy railroad. The coal is a splint, and widely used in **e** the blast-furnaces of eastern Kentucky in its raw state, for which purpose it enjoys a high reputation. Its usual thickness is 3½ to 6 feet.

Bed No. VIII is also mined at Coalton, where it is said to be 4 feet thick, but inferior in quality to No. VII.

Of the four upper beds little is known beyond the fact of their existence.

Owing to a lack of transportation facilities the coal of Kentucky has been hitherto but slightly developed, except in Greenup and Boyd counties, which are on the Ohio, a little on the Licking river, and a few entries on the Kentucky river. Consequently the quality of the coals is but imperfectly known. This state contains a larger proportion of cannel coal than any other, but it has never been developed and still lies buried in the ground. (*a*)

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a Since the above was written, a large amount of exploratory work has been done near the headwaters of Rockcastle creek, a branch of the Tug fork of the Big Sandy river, in Martin county, and near the headwaters of John's creek, a branch of the Levisa fork of the Big **f** Sandy, in Johnson county. This work has proved the existence of a valuable coal-field. There are here 5 seams of coal, each sufficiently thick to be exploited. The equivalency of these seams has not been fully made out, but it is believed that the seam locally known as "D" is the same as the Peach Orchard seam, No. III. This seam is 9 to 10 feet thick, but it contains so many slate and bone partings as to make its working unprofitable. Below "D" two seams have been opened upon, *i. e.*, "C," 30 to 60 inches thick, and "B," 36 to 40 inches thick. Above "D" the seam "E" varies from 50 to 72 inches in thickness, the average of thirteen measurements being nearly 58 inches. This is the most important seam thus far opened in this part of the state, and it has been explored sufficiently to determine its regularity and value over a considerable extent of territory. Above "E" the seam "F" is, at one opening, 11 feet thick; but it lies so high above drainage level that it is caught in the highest hills only, and it is probable, too, that the great thickness of the seam is but a local phenomenon. The coal from all these seems is free-burning, and it contains but little sulphur. The average of 8 cross-section samples from different openings on the seam "E," which were collected and analyzed by the writer of this note in 1882, is as follows: Water, 3.29 per cent.; volatile combustible matter, 36.16 per cent.; fixed carbon, 50.39 per cent.; ash, 10.16 per cent.; sulphur, 0.75 per cent. A railroad has recently been surveyed to this coal-field from the Ohio river.—BAYARD T. PUTNAM.

a 9. *The Tennessee coal-field* is but a prolongation southward of the eastern Kentucky field. Its area is co-extensive with that of the Cumberland mountain or table-land. The Cumberland mountain crosses Tennessee obliquely, and although much indented by valleys and coves, is nowhere completely cut in two by them. The eastern border of this table-land is comparatively a nearly direct or gracefully curving line, the indentations made by the streams on this side being scarcely noticeable. It is very irregular, however, along its western border, being cut out and notched by deep valleys and coves, separated from each other by long spurs jutting to the west. These deep indentations give the western outline a very ragged appearance. Along the Kentucky line the coal-field is about 70 miles wide, while it narrows along the Alabama line to 50 miles. The coal-field includes within its limits the whole of Scott, Morgan, and Cumberland counties, together with portions of Fentress, Van Buren, Bledsoe, Grundy, Sequatchie, Marion, Claiborne, Campbell, Anderson, Rhea, Overton, Putnam, White, Franklin, b Warren, and Coffee counties. A little east of the center this coal-field is split north and south by the Sequatchie valley, dividing it into parallel but unequal arms, extending through Bledsoe, Sequatchie, and Marion counties.

The sub-conglomerate coals embrace the whole of the coal region of Tennessee, except the northeastern and a part of the eastern section, and are apparently the coals which have been most thoroughly explored. The chief bed of the sub-conglomerate coals is worked at the Ætna mines in Marion county, where it is 3 feet thick. Hitherto the coals of Tennessee have not been carefully examined, so that it is extremely difficult to correlate them and put them in their proper places. It is known that there are three to nine sub-conglomerate coal-beds, which are none of them thought to be of very regular thickness, but to swell and contract locally. There are known to be twenty-one beds in the Coal Measures proper above the conglomerate, of which but one or two have been worked, and these chiefly at the Sewannee mines in Grundy county, where the main Sewannee seam is 3 to 7 c feet thick. More geological explorations are needed in order to locate the position of these coal beds precisely.

The market for the Tennessee coals, while comparatively local, is capable of great development for manufacturing purposes and local use. There are known to be both coking and splint or open-burning coals in the state which can be used for blast-furnace and rolling-mill purposes. Some of the coals are rich enough in volatile ingredients and sufficiently low in sulphur to be used for gas-making purposes. Then there are the great adjoining markets of South Carolina, Georgia, western Tennessee, and Mississippi, in which the coals will, in the future, be largely used as the manufacturing interests are developed. It is said that there is good cannel coal in the state, but if so, it has certainly not been developed.

10. *The Georgia coal field.*—The Tennessee coal-field west of the Sequatchie valley extends over the border into Alabama and then soon dies out. That on the eastern side of the valley, on the contrary, extends through d Dade, Walker, and Chattooga counties in Georgia into Alabama. Almost the whole of the former is underlaid by an excellent quality of bituminous coal, while there is not quite such an extent of it in the other two counties. The coal is largely mined to be shipped in a raw state and as coke to Chattanooga and other iron producing centers, as well as to the cotton factories and the Atlantic seaboard.

11. *The Alabama coal region* is an extension southward of the Georgia into northern Alabama. It is divided into three fields, the Black Warrior, the Cahaba, and the Coosa. Of these three the first is much the largest, extending from the Georgia line almost to Mississippi, covering the whole of Hancock and Walker counties, and parts of Tuscaloosa, Fayette, Marion, Franklin, Lawrence, Morgan, Blount, Jefferson, Marshall, Jackson, and De Kalb counties. The spurs of the Cumberland table-land which extend from Tennessee into Alabama have been but little explored, but the coals which occur are sub-conglomerate coals. Of about the same relative position are e the coals which are found in the Lookout mountain in Alabama. The lower part of the Warrior basin has been very little explored, except along the line of the South and North Alabama railroad. The coals which are worked in this basin seem all to be of sub Carboniferous age belonging to the conglomerates, but the identification of the beds seems to be still very doubtful.

With regard to the Coosa coal-basin, but little is known beyond the fact that there are at least three workable coal-seams, which are, respectively, 3, 4, and 3½ feet thick.

In the Cahaba coal-basin the coals vary in character, some being coking-coals, others dry open-burning coals. The field has been too little opened and explored to enable us to form a correct idea of its value. There seems to be two sets of Productive Coal Measures, one being of sub-Carboniferous age, the other belonging to the Lower Carboniferous Measures. Of these the former are in many places deeply buried. Along the western edge of the f basin but two coal seams have been recognized. It will require further examinations on the part of the geological survey of the state to recognize and differentiate the different beds.

This concludes the coal-fields of the Alleghany area. We come next to—

III. THE ILLINOIS, INDIANA, AND WEST KENTUCKY AREA.—The coal-measures of this portion of the United States form but one area.

1. *The Indiana coal-field.*—The Carboniferous Measures occur in the counties of Posey, Vanderburgh, Warwick, Spencer, Perry, Crawford, Gibson, Pike, Dubois, Knox, Daviess, Martin, Sullivan, Greene, Clay, Owen, Vigo, Parke, Vermillion, Fountain, and Warren; or, in other words, in the southwestern part of the State. There are three beds of coking-coal in this field, varying from 4½ to 10 feet in thickness, and three seams of open-burning or splint coals that range from 2½ to 5 feet in thickness, the average thickness being 4 feet. One bed of cannel coal

occurs in Daviess county, about 4½ feet thick. The principal coals mined with this exception are the block coals a from Clay county. The coal bears a high reputation for iron-smelting and steam purposes, is remarkably free from sulphur, and contains but a small amount of ash. As yet no consecutive report has been published by the geological survey of Indiana showing the exact relations of the different coal-beds. The coals all seem to belong to the coal-measures proper, with the exception of a sub-conglomerate bed which is mined in Martin county, where it is found 3 to 4 feet thick.

2. Passing south into *Kentucky* we find the area of the western coal-field to underlie the following counties in whole or in part, viz: Union, Crittenden, Caldwell, Hopkins, Christian, Webster, Henderson, Daviess, McLean, Muhlenberg, Butler, Ohio, Hancock, Grayson, Edmonson, and Hart. Twelve coal-beds have been recognized, but they vary in number in the different localities. Beginning with the top bed in the series included between the Anvil rock sandstone and the sub-Carboniferous conglomerate, the several coals may be briefly described as follows b

Coal A, more commonly known as No. 12, is present over a considerable extent of territory, but is seldom, mined, as its position near the summit of the Carboniferous formation usually brings it near the hill-top, and it is thus rarely found in a suitable condition for working, the covering being insufficient, and the coal too soft or too untrustworthy in its linear extent. When found in a workable condition, however, this coal is comparatively free from all irregularities of bedding, and is easily mined. When well developed it varies from 3 to 6 feet in thickness. This coal is too full of bitumen to be used in a raw state for smelting iron. It was tried in a furnace on Green river, and the quality of iron made was poor. It makes, however, an excellent coke.

Coal B.—This bed is, taking the field through, quite untrustworthy. It thins and thickens in a remarkable manner, and it is seldom free from slips. It is, however, more persistent than coal A. When workable, the coal is of fair quality as a fuel for general purposes, though rather too soft to be kept long after mining. This bed is c worked at many points in the coal-field, and often lies above drainage. It is found in Henderson and Daviess counties toward the Ohio, in the western parts of Union and Webster, in Hopkins and Muhlenberg counties, at many points in the southern part of Ohio county, and in McLean county.

Coal C is a very erratic bed, but seldom present. It has been observed in but few localities, and is of no practical value.

Coal D varies in its general quality and physical features, but has a remarkable uniformity in the amount of sulphur it contains. It is an admirable heating fuel, and is of peculiar value as such, when properly screened. It is too full of bitumen and too sulphurous for blast-furnace use. Its thickness varies from 4 to 6 feet. It is worked at many points along the Louisville, Paducah and Southwestern railroad, along the Saint Louis and Southwestern railroad, along the Evansville, Owensborough and Nashville railroad, in the southwestern portion of Union county, d toward the Tradewater river in Webster county, generally in Hopkins and Muhlenberg counties, in the northern portion of Daviess county, and in the southwestern portion of Ohio county.

Coal E is one of the most remarkable coals in its variations in thickness to be found in the field. It is sometimes entirely absent, and when present varies from ½ inch to 2½ feet in thickness. It is believed to be of such a superior quality when fully developed that a thickness of 3 to 3½ feet would be regarded as workable even in the region of thicker beds.

Coal F has not yet been found as a valuable bed in either an economic or a commercial point of view. But little is known in regard to it.

Coal G is a bed concerning which nothing is known beyond its existence.

Coal H has been seldom found. It is between 4 and 5 feet thick. e

Coal I is a bed of which little is definitely known. It has been found at a few points between 1 and 3 feet in thickness and apparently of good quality. It is above drainage in the southwestern quarter of Hopkins county, in Union county, the southern part of Ohio, and Muhlenberg counties.

Coal J varies from 2 to 3½ feet in thickness, and has been but little mined. Owing to a high percentage of mineral charcoal and sulphur it stands exposure but poorly. This bed is found in the country eastward of Caseyville, in Union county; around Petersburg, in Christian county, and frequently along the disturbance which extends through Union, McLean, Webster, Ohio, and Grayson counties.

Coal K is a bed of which scarcely anything is known, and which seems to be very limited in its distribution.

Coal L is the poorest coal having great extent in the Kentucky field. It is found above drainage, or but little below it, around the eastern, southern, and western margins of the field. It varies from 3½ to 5 feet in thickness, f and has been found in Hancock county, Union, Webster, McLean, and Ohio, into Grayson county. The coal has been mined at the Coaltown banks, in Christian county; in the vicinity of Tradewater station, in Hopkins and Caldwell counties; in the district around Caseyville, in Union and Crittenden counties; near Wrightsburg, in McLean county, and has been opened at a number of points in Edmonson, Grayson, and other counties.

All of these coals are of sub Carboniferous age, and therefore older than any of the coals mined in Pennsylvania and Ohio.

The Breckinridge cannel coal is the first coal above the sub-Carboniferous series. It is celebrated for its remarkable properties as an oil-producer and a gas-enricher. This coal is so rich in volatile bituminous matter that oil was distilled from it prior to the discovery of petroleum, and it was at one time shipped to New York as an

a enricher in the gas works. This bed seems to be confined to Breckinridge and Hancock counties. The seam is 22 to 38 inches thick. The coal is remarkably dense and tenacious. More oil can be obtained from it than from the famous Scotch Bog-Head cannel, which yields 72 gallons of oil and 12 pounds of paraffine, while the Breckinridge cannel yields 92 gallons of marketable oils to the ton. Its chief use at present is as a gas-enricher.

As yet the coals of this western Kentucky field have been but little exploited, and there does not seem to be any probability of the majority of the seams being extensively opened for many years, since there is but little market for these coals, except for domestic use, so long as the Pennsylvania, Ohio, and West Virginia coals can be floated down the Ohio river very cheaply.

3. The western portion of this coal area is occupied by the *Illinois coal-field.* The coals of this field are generally highly charged with sulphur, often contain a high percentage of water, and disintegrate on exposure to the b atmosphere. As a result the exploitation has been almost entirely confined to such coals as are needed for steam-raising and domestic use. The coal-measures cover the lower two-thirds of the state, and according to official reports there appear to be sixteen seams, but they all appear to be of about the quality above mentioned, with the exception of that mined in Jackson county. The coal mined here, known as "Big Muddy" coal, breaks into cubes and somewhat resembles the block coals of Ohio. It contains less sulphur, and is a harder and firmer coal than any mined elsewhere in the state. It has been used in blast-furnaces around Saint Louis.

The heaviest deposits of coal to be found in the northern portion of the coal-field are in Schuyler and Fulton counties, but owing to their distance from any large centers of consumption, the coal-beds of other portions of the state have been much more extensively opened. We pass next to another portion of the country, and come to--

IV. THE MICHIGAN COAL-AREA.—The coals of this district are very inferior in quality, and have been so little c developed that but little is known concerning them. The only coal mined is in Jackson and Ingham counties, and that only for local use.

V. THE IOWA, MISSOURI, KANSAS, ARKANSAS, AND TEXAS AREA.

1. *The Iowa coal-field.*—Its boundaries correspond nearly with the east line of Van Buren and Jefferson counties, curving a little eastward into Lee. From the northeast corner of Jefferson county the line pursues a little northwest course, passing near the northwest corner of Keokuk and the northeast corner of Mahaska county to the middle of the south line of Marshall county; running thence to Hardin county it passes westward to Hamilton and Dodge counties, beyond which its boundary is uncertain.

The center of the coal-field of southern Iowa lies in the triangle between the cities of Ottumwa, Albia, and Oskaloosa. Taking Eddyville as a center, and describing a circle of 20 miles' radius, it would embrace the territory d that produced two-thirds of the entire coal product of the state. Within this circle there are three coal-beds. The upper one is 15 to 30 inches thick in the eastern borders of Lucas and Warren counties, and 23 inches thick in the western edges of Jefferson and Keokuk counties, and is everywhere mined by drifts in the hillsides. In the central parts of the district this coal is sometimes deeper, and is worked by shafts 40 to 50 feet deep, the seam being at times thicker, 3 to 4½ feet. The lower seam of coal has only been worked in the shafts of the Whitebreast Company, the Albia Coal Company, and one or two other points.

In Mahaska county the lower coal is worked, presenting a thickness of 5 to 8 feet.

In the neighborhood of Des Moines mines have been opened in the valley of the Des Moines river, where three coal-beds, each too thin to be economically worked, come so close together that they are all mined together.

Near Fort Dodge coal is taken from a seam 5 to 6 feet thick, and this promises to be one of the important e fields of the future.

The coals of this field are all bituminous. The coals are inferior in quality, as regards the amount both of moisture and sulphur, which they contain, and can only be used for domestic and steam-raising purposes.

Passing south from Iowa, we come next to—

2. *The Missouri coal-field.*—This occupies the northern and northwestern part of the state, as well as the so-called "Osage" coal district. The best coals occur near the base of the formation. The use of the coals is entirely local, as they are of very inferior quality. The coals of the Osage district consist of a number of local deposits of limited extent, but of great thickness. They do not present the usual appearance of coal-seams, and are associated with the rocks which it is supposed would accompany them, but they occur in ravines in the older rocks below the level of the regular coal-seams. These local deposits furnish some of the best coal in the state. f They occur near the mouth of the Osage river, in Cooper, Moniteau, Cole, Morgan, and Callaway counties. In appearance these coals are between cannel coal and asphaltum, but they contain 31 per cent. less volatile matter than pure bitumen, and 5 to 10 per cent. more than the ordinary bituminous coals of the west.

3. *The Kansas coal-field* occupies the southeastern portion of the state. The Upper Coal Measures contain no coal-beds of any value, but the Middle Coal Measures produce a bituminous coal of fair value. There are three principal beds, viz, the Osage, the Cherokee, and the Fort Scott. The Osage bed is found in Osage county. It is 15 to 30 inches thick. It is mined partly at the surface, partly by shafts 20 to 30 feet deep. The Fort Scott coal appears at and near the surface in various parts of Bourbon and Linn counties. The thickest and best coal-seam is the Cherokee bed, found in Cherokee, Crawford, and Labette counties. Like all the other strata, it dips northwest. It is 15 to 54 inches thick, and is freer from impurities than any other coal found in Kansas.

4. *The Arkansas coal-field.*—The coals of this state all seem to belong to the sub-Carboniferous conglomerate. a The coal-field covers the counties of Washington, Crawford, Sebastian, Franklin, Scott, Johnson, Yell, Pope, Perry, Conway, White, and Pulaski. Only two beds of coal have been found, of which only the lowest one is of sufficient thickness to work. This coal is in places semi-bituminous, in places semi-anthracitic in character, and in the future may be worked to advantage in developing the iron ores of the state. At present the mining is confined to what is needed for local use.

In reviewing the different coal areas of the United States it will be noticed that they diminish in value in passing from east to west. The anthracite districts of Pennsylvania are the most valuable, the coals of the western states the least. While of similar age, the coals of the east have been far more disturbed since their deposition than those of the west, and it would seem as if the greater the disturbance so much the greater became the value of the coals. While in the northern portion of each coal-area the upper coals appear to be the most valuable and b the sub-Carboniferous to be valueless, this law becomes reversed on going south, where the sub Carboniferous coals become of great value and the upper coals either disappear or become valueless.

Details for the census were not available in the Indian Territory. Valuable beds of coal are worked in the Choctaw Nation, supplying the railroads of the region and of a part of Texas, and furnishing coal, especially to gas companies, for the cities of Kansas and of Texas. The Choctaw Nation derives a considerable revenue from the royalty paid for the coal mined.—*Superintendent of Census.*

CHARACTERISTICS OF OHIO COALS.

By Edward Orton.

The coal-lands of Ohio are a section of the most important of the North American coal-fields, viz, that which is known as the Appalachian or Alleghany field, but which might more appropriately be termed, as has recently been suggested, the Ohio Valley coal field, almost its entire drainage being directed to the Ohio river. Of this field the Ohio section constitutes the northwestern portion—thirty-one counties, in whole or in part, lying in the eastern and southeastern portion of the state, are occupied by rocks of Carboniferous age. The entire area of this c formation in Ohio is nearly or quite 12,000 square miles, and coal-seams are due in all of it, but the geological surveys of the state so far made have not been on a minute enough scale to furnish a proper basis for estimating the actual amount of coal included within these limits. There are at least 1,200 feet of stratified deposits in the general section of the field, and inclosed within these 1,200 feet there are not less than 23 distinct coal-seams, from 18 or 19 of which coal is mined to a greater or less extent. Several of these seams occupy wide areas and are exceptionally steady and regular, but more of them are inconstant in their development, and a few are confined to very small areas, as far, at least, as workable thickness is concerned.

All of the Ohio coals belong to the bituminous division, but there are among them several well-marked varieties, the most important of which are the following, viz, (1) open-burning or dry-burning coals, (2) cementing or coking coals, (3) cannel coals. d

The last-named of these varieties has but a limited development in the state. It is at present nowhere mined by itself for the general market, but local deposits that are met in the working of ordinary seams, are brought out and sold separate from the common product. The only technical use of Ohio cannel coals is the enriching of gas. For this purpose the small volume of cannel reached in the mines of northeastern Ohio is in good demand, at remunerative rates. There are a number of cannel-coal fields proper in the state, which have not yet been worked, except in a small way. Their products are, in several instances, highly esteemed for household use in the neighborhoods in which they occur.

The first and second of the varieties named above constitute, in reality, all of the Ohio coals that reach the general market. Both of them are turned to large account for domestic fuel and for the production of steam; but in addition to these common and general uses, each variety has its special adaptations and technical characteristics. e

1. Open burning coals.

Of the open-burning coals there are many subordinate varieties and great differences in quality. The eight lowermost seams of the state are open-burning; the ninth, Coal No. VI, of Newberry, which is the most valuable of the Ohio series, is a typical open-burning coal throughout the western half of its extent, and an excellent coking coal throughout much of its eastern area. Several of the remaining coal-seams belong to the open-burning variety, but the most of them are coking coals. It can therefore be said, in the large way, that the lower seams of the Ohio series are open-burning, and the upper seams cementing coals.

There are three of the lower coals that are well adapted, in the raw state, to the manufacture of iron, in one or more localities. These seams are (1) the Mahoning valley block-coal, the Massillon coal, and the Jackson f court-house shaft coal, which are counted geological equivalents, all of them belonging to coal No. I of Newberry's classification; (2) the Wellston or Jackson Hill coal, which is No. II of Newberry, and (3) the western half of the Nelsonville coal, which is No. VI of Newberry. Each of these coals is largely used, and well approved for furnace use. The points that commend them, in addition to their open-burning quality, which is of fundamental importance, are the following, viz, a high percentage of fixed carbon, a comparatively low percentage of ash and also of sulphur. The Mahoning Valley coal, the Youngstown coal, the Brier Hill coal, the Sharon coal—for by all these names and more the seam is known—has been for many years the basis of a large production of iron, including Bessemer, pig, and car-wheel iron in northeastern Ohio and in adjacent parts of Pennsylvania. It has often been used as the sole fuel in the furnaces of the district, but of late years one-half or two-thirds of the fuel used is Connelsville coke. The Mahoning Valley coal is the type of furnace coals. It mines large; is unusually firm and

a strong, and is low in ash and sulphur. The analyses that are at hand were made from selected samples and, as is well known, but little value generally attaches to the results of such analyses, from the fact that there are but very few seams of coal from which excellent specimens cannot be taken. But in this case the results of furnace use on the large scale agree with the laboratory analyses in indicating unusual excellence in the seam. In addition to this, the number of analyses is now very large, and all agree essentially in character. It can, therefore, be asserted with all confidence that we have in this seam one of the purest coals of the country. A single analysis of the Brier Hill coal is appended, which shows the coal at its best. The analysis was made for the Ohio Geological Survey, by Professor T. G. Wormley, the chemist of the survey.

b *Analysis of Brier Hill coal.*

	Per cent.
Specific gravity	1.26
Moisture	2.47
Ash	1.45
Volatile matter	31.83
Fixed carbon	64.25
Total	100.00
Sulphur	0.56

c

If the seam should be sampled from top to bottom, and all that goes into the furnace should be duly represented in the analysis, it is certain that the proportions of ash and of sulphur would be increased beyond the figures given above, but they would still be moderate—the former would not probably exceed 4 per cent., and the latter would fall within 1 per cent. An ultimate analysis of the coal reported by Dr. Newberry gives but a trace of phosphorus.

The Massillon coal of Stark county belongs to the same horizon and exhibits the same general characteristics as the Mahoning Valley coal, and needs no further description here. The Jackson shaft coal of southern Ohio, which has been named as another probable geological equivalent of the Mahoning Valley coal, is also the basis of an extensive manufacture of pig-iron. The coal differs, however, in several respects from the seam, as already d described. It is a tender coal and does not bear shipping well, and it is richer in mineral charcoal than the northern coal, but, like the latter, it is very pure and has high calorific power. An analysis of the seam made by Dr. Robert Peter, of Kentucky—not from selected samples, but from the whole seam as it occurs in the mines—gives the following results:

	Per cent.
Specific gravity	1.361
Water	4.54
Volatile combustible matter	29.68
Fixed carbon	57.06
Ash	8.72
Sulphur	0.758

e

This analysis agrees well with the analysis of selected samples as reported in the volumes of the Ohio Geological Survey, except in the proportion of ash, which is more than double the average of the figures there reported. It is altogether probable that these results are nearer the facts for the seam at large than the smaller amounts.

The coal is used in the furnace without any admixture of coke, and the ores are also exclusively native ores. The grades of pig-metal produced are not as high as those already described from northeastern Ohio, but still Jackson court-house is the seat of a thoroughly-established and thoroughly-successful iron manufacture. The iron is somewhat deficient in strength, but is well adapted to foundery purposes, and, in short, answers almost every f purpose for which "Scotch pig" can be used.

There are, then, three centers of iron production in Ohio for which the lowest of our coal-seams furnishes, in whole or in part, the fuel.

Coal No. II of Newberry is a very uncertain seam. There is, in fact, but one small basin in the state in which the seam reaches any considerable value. That basin is in Jackson county, and includes the Jackson Hill or Wellston coal, the two names being applied to the same seam. Four furnaces are working on this seam, relying upon it exclusively for fuel. The Wellston coal is somewhat tender and friable, and does not bear shipping very well, but it is a fuel of high quality. The percentage of sulphur rises above that reported for the Jackson Shaft coal, but the proportion of ash is smaller. It is about equal in calorific power to the last-named seam.

The only remaining seam in the state that is used in the raw condition in iron furnaces is the ninth seam in ascending order, or coal No. VI of Newberry. This seam is a coking coal for the eastern half of its extent and an

open-burning coal from Perry county southward. It is the basis of the last-developed but most promising center a of iron production of the state, that, namely, of the Hocking valley. In steadiness and volume the Hocking Valley coal far surpasses any of the fields thus far named. In purity it does not attain quite as high rank as that of the Mahoning Valley coals, but the whole seam in its best development scarcely rises above 1 per cent. in sulphur. The proportion of ash according to most of the published analyses is less than 3 per cent., but the portions of the seam that yield less than 6 per cent. for the whole product that goes into the furnaces are probably very rare. The fixed carbon averages more than 55 per cent., ranging from 52 per cent. to 61 per cent. Sixteen furnace-stacks have been built to run upon this seam, in whole or in part, in the Hocking valley and in regions directly dependent on its coal. The products of several of these furnaces are noted for unusual strength and excellence, the mill-iron produced competing in market with charcoal iron, a result which obviously attests the high character of the fuel used, although the native ore that is worked comes in for a share of the credit. b

A few analyses of picked samples of the Hocking Valley coals are here appended, and three averages, somewhat more reliable, are added:

No. 1 is from the mines of W. B. Brooks, Nelsonville. No. 2 is from the mines of Peter Hayden, Haydenville. No. 3 is from the McGinniss mines, Straitsville. No. 4 is average of seven analyses of whole seam, Sunday creek. No. 5 is average of twenty-seven analyses of coal from Sunday creek. No. 6 is average of whole seam, Nelsonville.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Specific gravity	1.259	1.271	1.247	1.30	.....	1.32
Water	6.80	6.45	6.00	6.42	5.34	3.47
Volatile matter	33.27	32.74	32.15	33.87	31.40	35.05
Fixed carbon	57.46	58.56	59.41	54.17	58.17	55.12
Ash	2.47	2.25	2.44	5.54	5.09	6.02
Total	100.00	100.00	100.00	100.00	100.00	99.66
Sulphur	0.74	1.19	0.50	0.88	0.88	1.73

c

Washington furnace, Jackson county, must be named as another separate center of iron manufacture dependent on this same coal-seam. Raw coal is used exclusively in the furnace, and all of the ores are mined on the furnace lands. A high degree of success at present attends the handling of these materials, but it was attained only after d several years of experiment and comparative failure.

The same seam retains its character as a furnace-fuel on the south side of the Ohio river. It is known as Coal No. 7, of the Kentucky survey, and has been successfully used in blast-furnaces for a number of years at Ashland, Kentucky, and also at Ironton, Ohio.

The Hocking Valley coal in some of its phases is well esteemed as a gas-coal, the main drawback being in the inferior quality of the coke produced. It is also used successfully in several iron-mills, but this branch of its applications has been but little developed as yet.

2. Cementing coals.

e

The cementing coals of Ohio are used, beside their general application, for the following purposes, viz: For the production of coke, for the manufacture of gas, and for fuel in puddling-furnaces and iron-mills. The line of division between them and the coals of the first group is partially geological and partly geographical. As has been already stated, they are confined to the upper half of the seams of the state, no coal below the 9th seam in ascending order (No. VI of Newberry) being known to yield an approved coke. It is now to be added that the cementing coals are more fully developed on the eastern side of the coal-field of Ohio than on the western side. There is but a single point to the south and west of Zanesville where coke is now manufactured in the state, and the coke-production of this one point, viz, Nelsonville, is insignificant, as is that also of Zanesville. At Uhrichsville, in Tuscarawas county, a small production has been maintained for a number of years, but the largest center of production is Steubenville and vicinity. An exceptionally pure and strong coke is manufactured at Washingtonville f and at Leetonia in Columbiana county; but all that is produced at these points is used in the local furnaces.

This last-named coke is derived from the eastward extension of the Hocking Valley coal-seam, as are also the Zanesville and Uhrichsville cokes. The Nelsonville coke is made from the coal of the 11th seam in ascending order, viz, No. VI*b* of the Ohio Geological Survey. To this horizon is also referred the Steubenville coking coal. The coal of neither of these seams has as yet obtained any unusual reputation as gas-making coal, though coal from each is fairly well adapted to gas-making in the phases here noted.

For the manufacture of gas a decided preference is given to the main seam of our upper series, viz, coal No. VIII, of Newberry. This is known as the Pittsburgh coal, the Wheeling coal, the Pomeroy coal, etc. Its best conditions for these technical uses are found outside of the boundaries of the state; but within these boundaries there is a large amount of coal well adapted to these purposes.

a This seam is largely used in puddling-furnaces, rail-mills, and nail-works, in all of which it does excellent service. In the vicinity of Bellaire the largest nail production of the country is located, and coal of this seam is exclusively used.

Coal of the same seam at Pomeroy is very extensively used in salt manufacture; but for this purpose an accessible fuel at low price is the only desideratum. The Pomeroy coal has an excellent reputation for every one of the purposes named above, but it is not largely coked.

From this brief review it will be seen that three seams of Ohio coal make the chief contributions to the metallurgical work carried on within the state. These seams are, respectively: Coal No. I, of Newberry, open-burning. Coal No. VI, of Newberry, cementing in eastern Ohio, open-burning in southern Ohio. Coal No. VIII, b of Newberry, cementing.

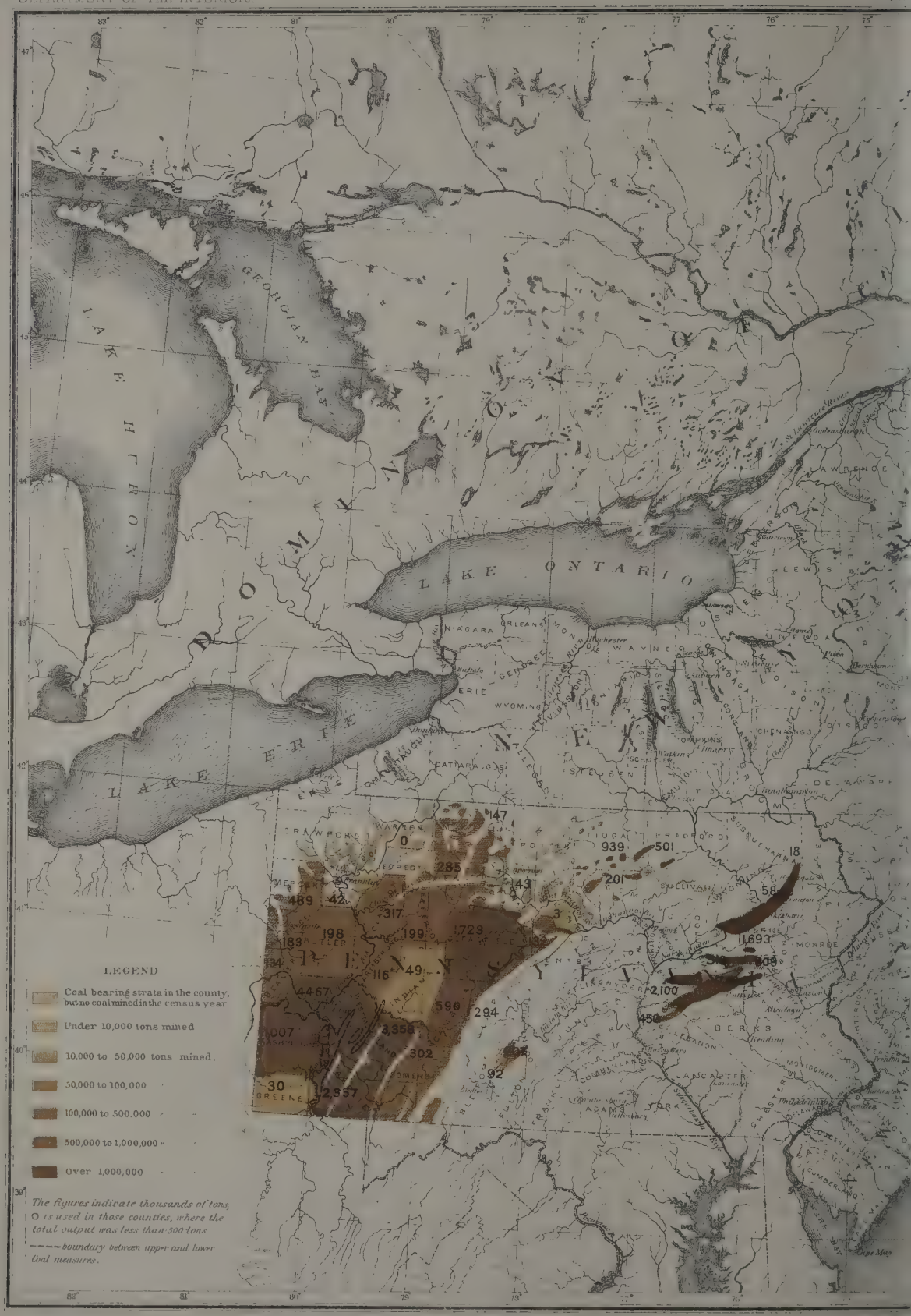
These seams are reinforced in different sections of the state by two other seams, viz: Coal No. II, open-burning. Coal No. VI*b*, moderately cementing.

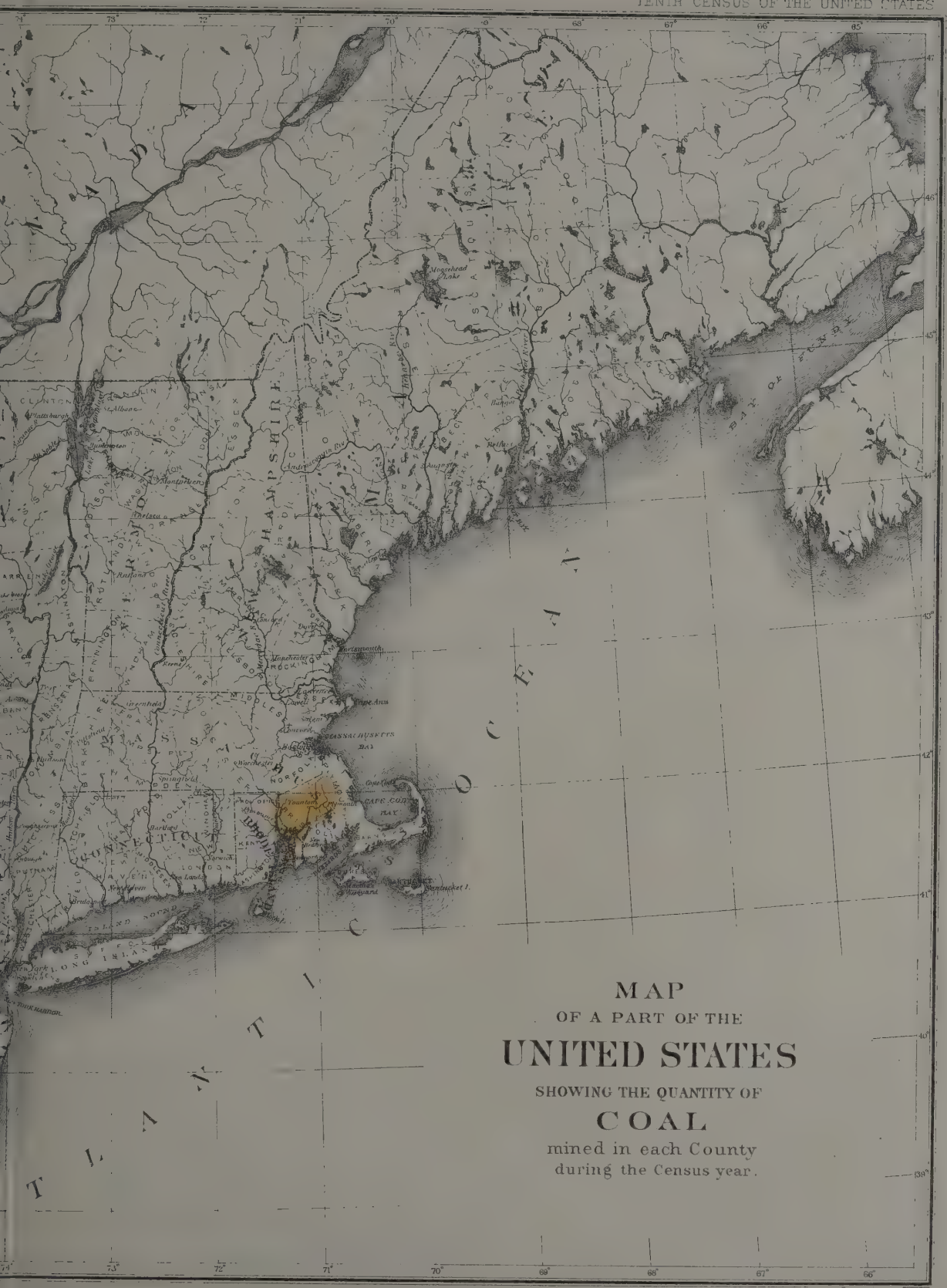
In regard to the numbering and identification of the coals above referred to, it must be acknowledged that the geologists of the state are not entirely agreed; and as to several points, nothing more can be claimed than an individual but positive opinion.

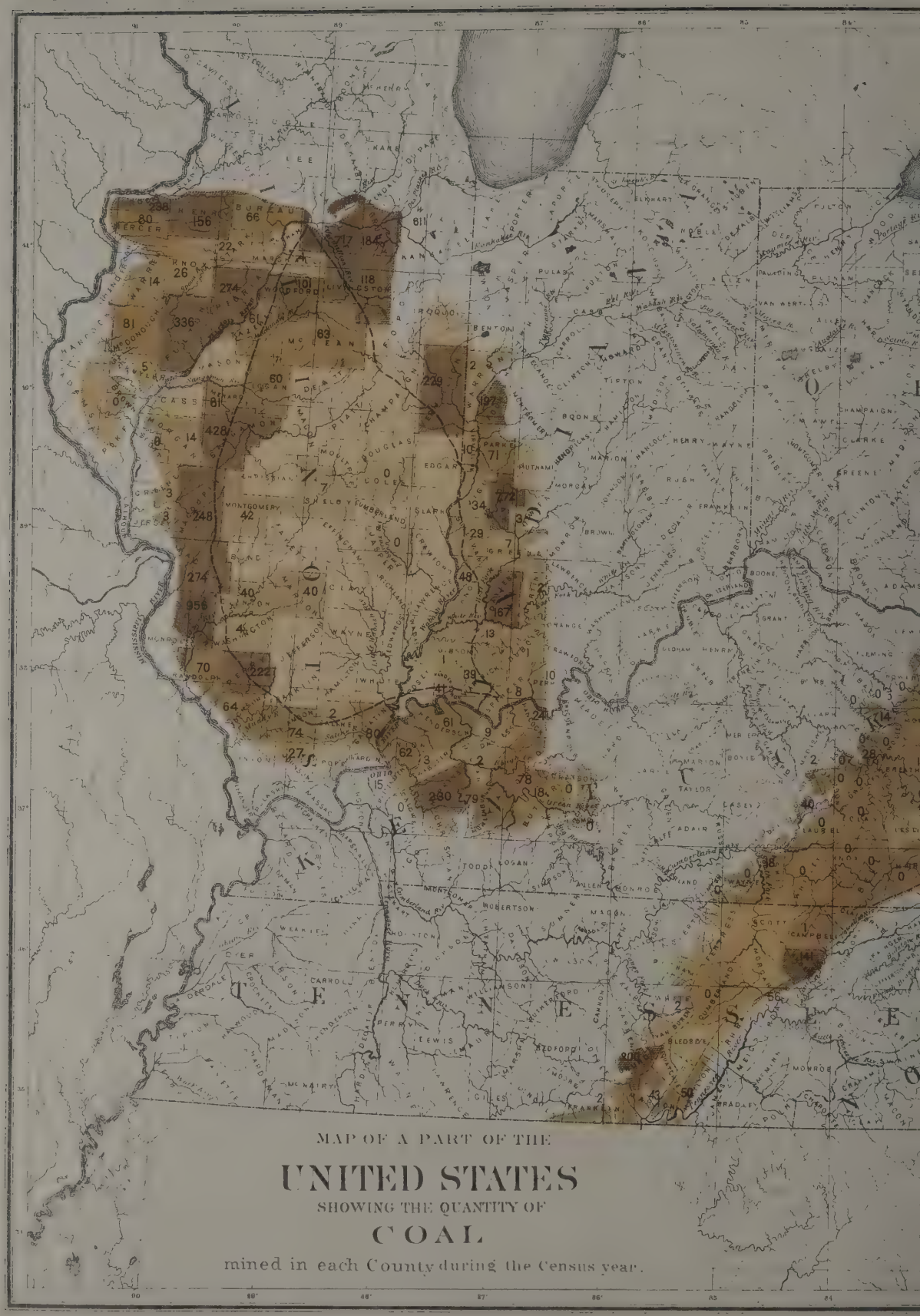
STATISTICS

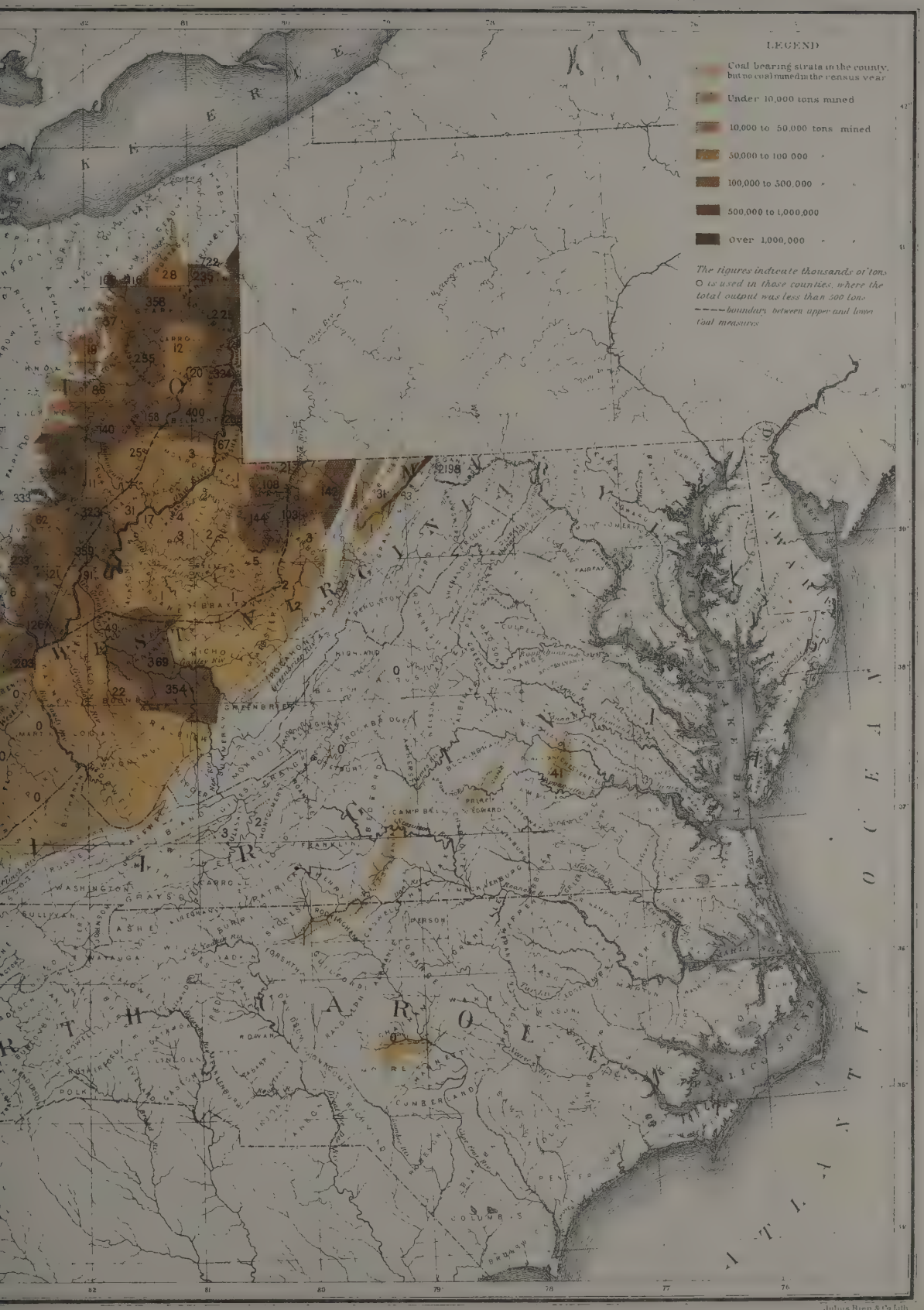
OF THE

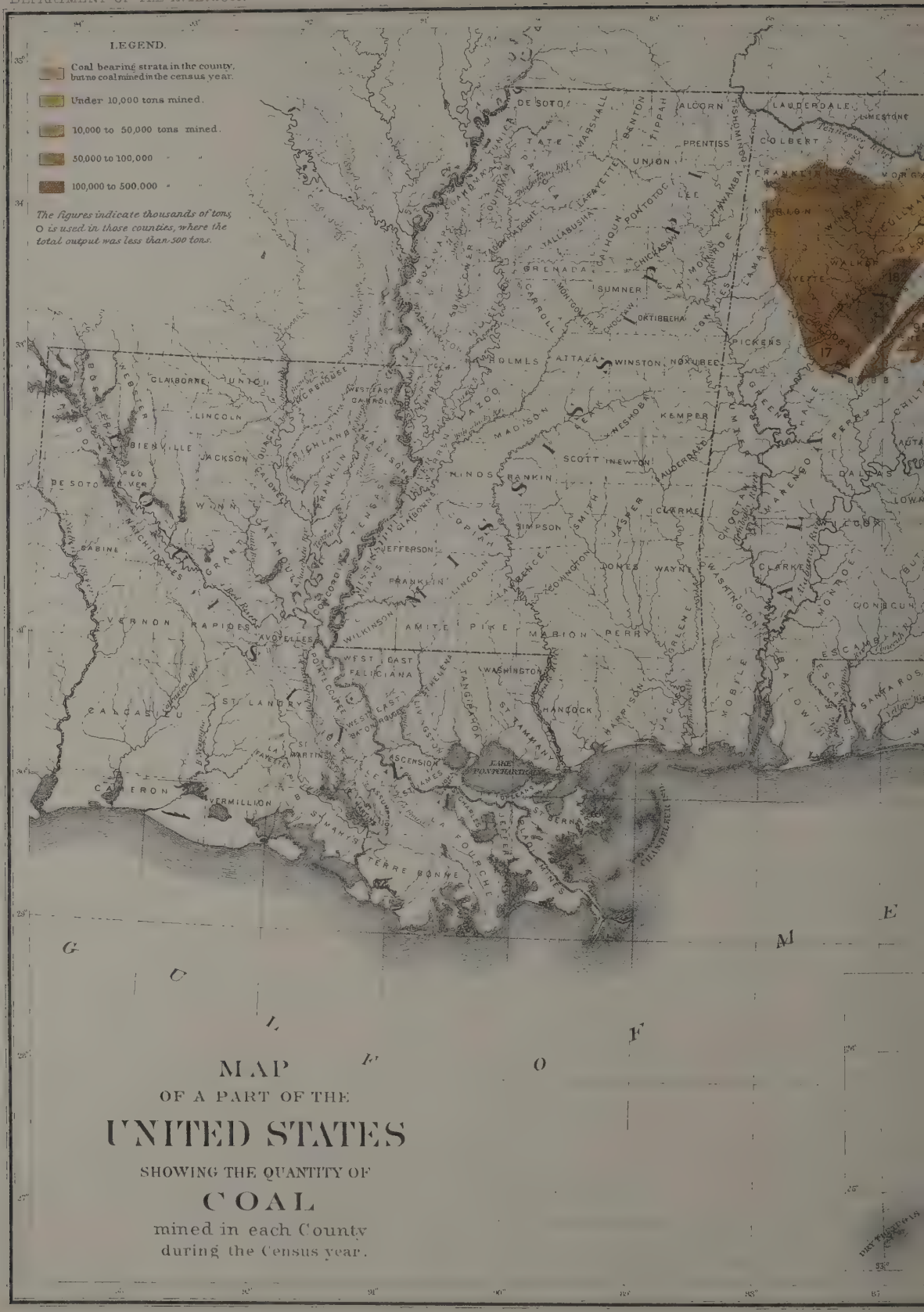
PRODUCTION OF ANTHRACITE COAL IN THE CENSUS YEAR.

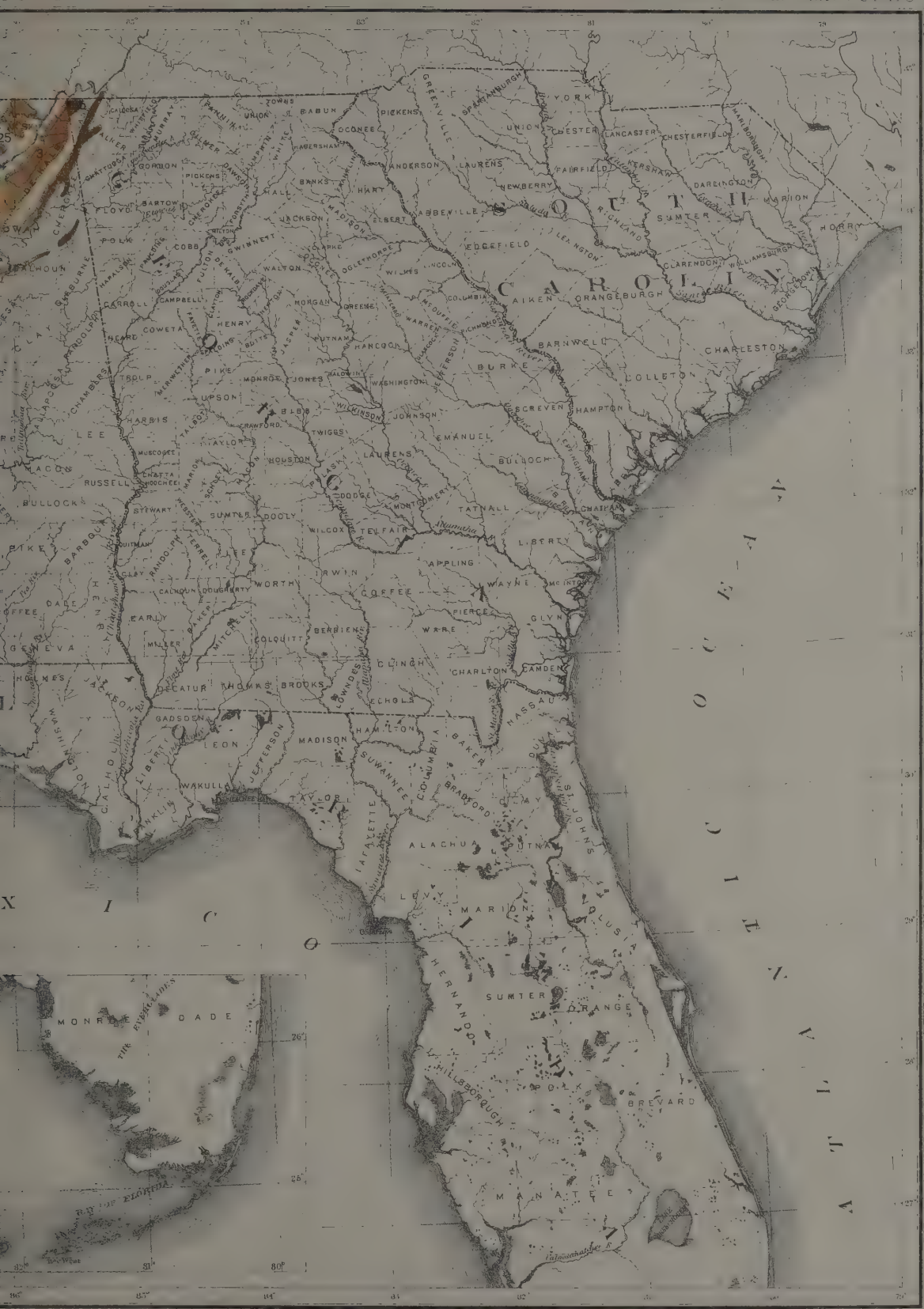

LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
DOMINION OF CANADA
NEW YORK
PENNSYLVANIA
NIAGARA
ORLEANS
WAYNE
ERIE
WYOMING
CATTARAUGUS
STEUBEN
SCHUYLER
TIOGA
BROOME
CHENANGO
MONROE
BERKS
LEBANON
LANCASTER
ADAMS
YORK
CHESTER
DELAWARE
CUMBERLAND
FULTON
BEDFORD
GREENE
147
0
285
143
939
501
18
201
58
489
42
317
3
198
199
723
1,693
189
134
116
49
2,100
4,467
590
294
450
3,358
302
92
30
2,357
LEGEND
Coal bearing strata in the county, but no coal mined in the census year
Under 10,000 tons mined
10,000 to 50,000 tons mined.
50,000 to 100,000
100,000 to 500,000
500,000 to 1,000,000
Over 1,000,000
The figures indicate thousands of tons, O is used in those counties, where the total output was less than 500 tons
boundary between upper and lower Coal measures.

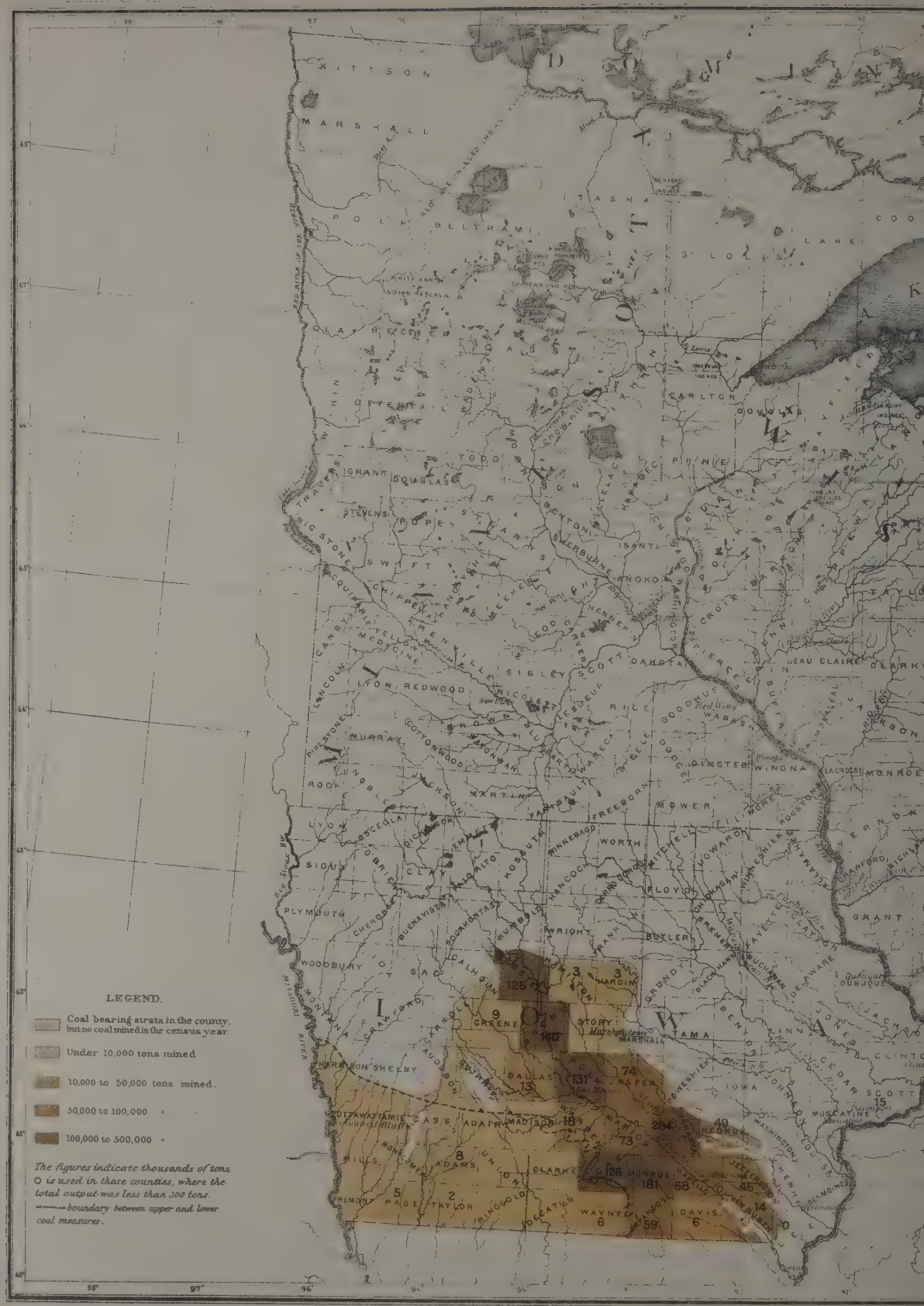

MAP
OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County
during the Census year.
CLINTON
Plattsburgh
Albany
Montpelier
Orleans
Andover
Concord
Portsmouth
Manchester
Keene
Lowell
Cape Ann
Worcester
Springfield
Hartford
New Haven
New London
Norwich
Providence
Taunton
Cape Cod
Nantucket I.
Vineyard
Mt. Desert
Bangor
Moosehead Lake
Katahdin
Rangeley
Sebago
Winnipesaukee
Ossipee
Sunapee
Ascutney
Mansfield
Greylock
Tom
Frost
Bear
Hancock
Washington
Franklin
Grafton
Cheshire
Sullivan
Rockingham
Strafford
Belknap
Carroll
Coos
Essex
Franklin
Hamilton
Herkimer
Oneida
Lewis
Jefferson
Saint Lawrence
Clinton
Warren
Washington
Rensselaer
Saratoga
Hampden
Hampshire
Franklin
Berkshire
Worcester
Middlesex
Essex
Norfolk
Bristol
Plymouth
Barnstable
Dukes
Nantucket
Hartford
Tolland
Windham
Litchfield
New Haven
New London
Fairfield
Middlesex
Tolland
Windham
Kent
Sussex
Orange
Rockland
Putnam
Dutchess
Ulster
Greene
Schoharie
Albany
Rensselaer
Columbia
Delaware
Otsego
Chenango
Madison
Oneida
Herkimer
Fulton
Hamilton
Saint Lawrence
Franklin
Clinton
Essex
Warren
Washington
Saratoga
Schenectady
Montgomery
Fulton
Hamilton
Herkimer
Oneida
Lewis
Jefferson
Saint Lawrence
Clinton
Essex
Warren
Washington
Rensselaer


MAP OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County during the Census year.

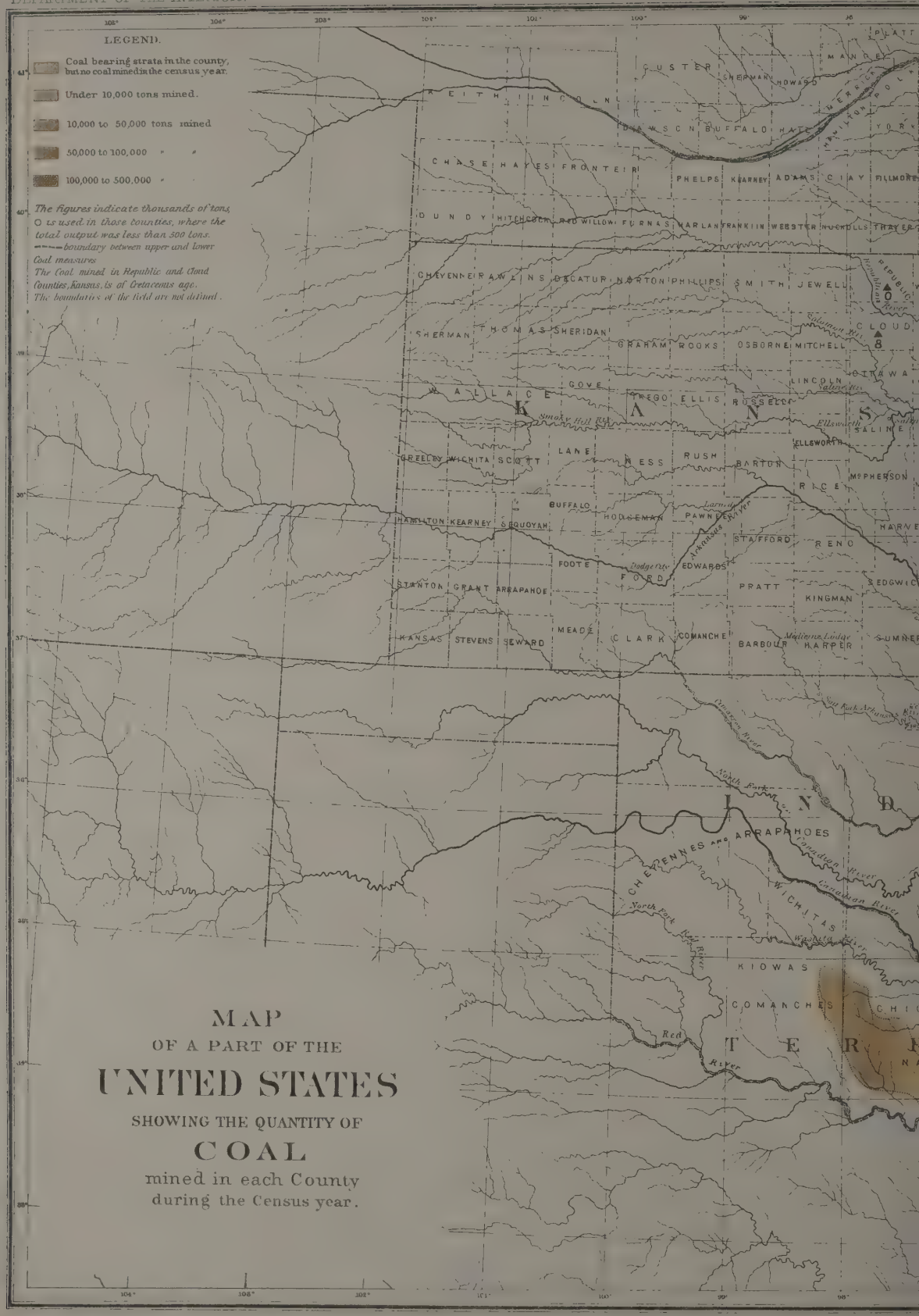

LEGEND
Coal bearing strata in the county, but no coal mined in the census year
Under 10,000 tons mined
10,000 to 50,000 tons mined
50,000 to 100,000 "
100,000 to 500,000 "
500,000 to 1,000,000 "
Over 1,000,000 "
The figures indicate thousands of tons
O is used in those counties, where the total output was less than 500 tons
boundary between upper and lower Coal measures
ATLANTIC OCEAN
NORTH CAROLINA
VIRGINIA
TENNESSEE
GREENBRIER
FRANKLIN
WASHINGTON
GRAYS
ASHE
WATAUGA
PERSON
WAKE
ROWAN
POLK
CUMBERLAND
COLUMBUS
BRUNSWICK
PENDER
FAIRFAX
CULPEPER
ORANGE
BRUNSWICK
PRINCE EDWARD
CAMPBELL
BEDFORD
BLACKSMITH
BRAXTON
NICHO
BELMONT
WAYNE
STAFF
LAURE
KNOX
FAIRFIELD
HIGHLAND
ROCKBRIDGE
MONROE
GREENBRIER
PATRICK
HENRY
ALLEGHANY
CARROLL
GRAYSON
WYTHE
BLAND
TAZEWELL
RUSSELL
BUCHANAN
DICKENSON
WISE
LEE
SCOTT
ROCKINGHAM
SHENANDOAH
FREDERICK
CLARKE
LOUDOUN
FAUQUIER
RICHMOND
ESSEX
KING GEORGE
STAFFORD
PRINCE WILLIAM
ALEXANDRIA
ACCOMACK
NORTHAMPTON
NORFOLK
PORTSMOUTH
CHESAPEAKE
SUFFOLK
ISLE OF WIGHT
JAMES CITY
YORK
NEW KENT
HENRICO
CHESTERFIELD
PETERSBURG

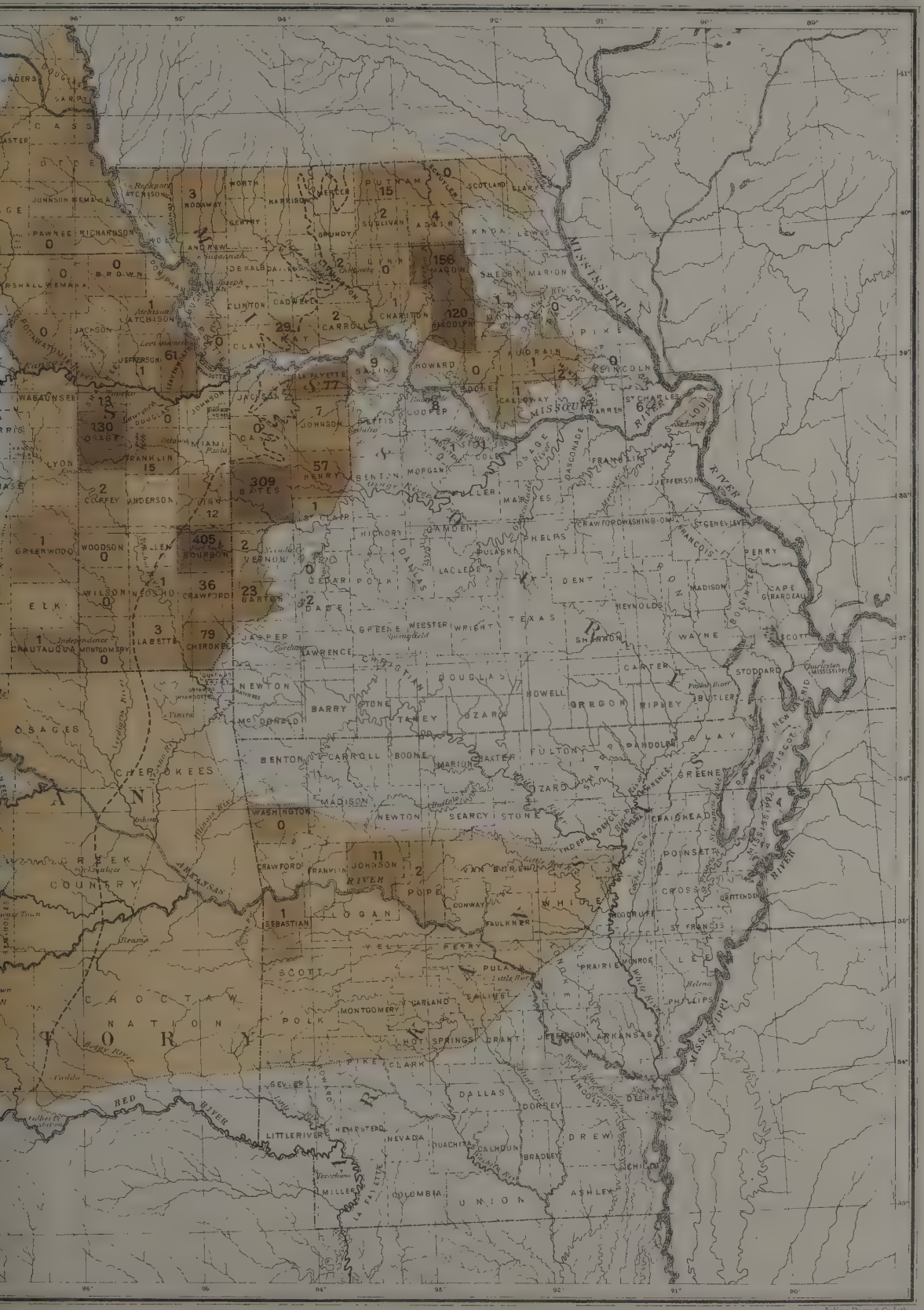

LEGEND.
Coal bearing strata in the county, but no coal mined in the census year.
Under 10,000 tons mined.
10,000 to 50,000 tons mined.
50,000 to 100,000 "
100,000 to 500,000 "
The figures indicate thousands of tons, O is used in those counties, where the total output was less than 500 tons.
MAP
OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County
during the Census year.
GULF OF MEXICO
DE SOTO
TATE
MARSHALL
BENTON
TIPPAH
ALCORN
LAUDERDALE
LIMESTONE
PRENTISS
COLBERT
UNION
LEE
GRENADA
SUMNER
OKTIBBEHA
PICKENS
HOLMES
ATTALA
WINSTON
NOXUBEE
CLAIBORNE
LINCOLN
KEMPER
BIENVILLE
JACKSON
SCOTT
NEWTON
RANKIN
DE SOTO
WINN
SIMPSON
CLARKE
SABINE
JEFFERSON
FRANKLIN
JONES
WAYNE
VERNON
RAPIDES
AVOYELLES
WILKINSON
AMITE
PIKE
MARION
PERRY
WEST FELICIANA
EAST FELICIANA
WASHINGTON
CALCASIEU
ST LANDRY
ST MARTIN
ASCENSION
HANCOCK
CAMERON
VERMILLION
TERRE BONNE
LAKE PONTCHARTRAIN
ESCAMBIA
SANTA ROSA


SOUTH CAROLINA
ATLANTIC OCEAN
GULF OF MEXICO
BAY OF FLORIDA
YORK
CHESTER
LANCASTER
CHESTERFIELD
MARLBOROUGH
UNION
FAIRFIELD
KERSHAW
DARLINGTON
MARION
HORRY
SUMTER
NEWBERRY
LAURENS
ANDERSON
GREENVILLE
SPARTANBURG
PICKENS
OCONEE
ABBEVILLE
EDGEFIELD
LEXINGTON
CLARENDON
WILLIAMSBURG
GEORGETOWN
AIKEN
ORANGEBURG
BARNWELL
CHARLESTON
COLLETON
BURKE
SCREVEN
HAMPTON
EMANUEL
BULLOCH
TATTNALL
CHATHAM
LIBERTY
APPLING
WAYNE
McINTOSH
GLYNN
PIERCE
WARE
CHARLTON
CAMDEN
NASSAU
CLINCH
ECHOLS
BERRIEN
COFFEE
IRWIN
TELFAIR
WILCOX
DODGE
MONTGOMERY
TOOMBS
BROOKS
THOMAS
DECATUR
GADSDEN
LEON
MADISON
HAMILTON
SUWANNEE
COLUMBIA
BAKER
BRADFORD
CLAY
ST JOHNS
PUTNAM
ALACHUA
LEVY
MARION
SUMTER
ORANGE
POLK
BREVARD
HERNANDO
HILLSBOROUGH
MANATEE
MONROE
DADE
THE EVERGLADES
WAKULLA
JEFFERSON
TAYLOR
LAFAYETTE
GILCHRIST
COLQUITT
MITCHELL
EARLY
MILLER
CALHOUN
DOUGHERTY
WORTH
TIFT
CRISP
DOOLY
SUMTER
STEWART
QUITMAN
CLAY
RANDOLPH
TERRELL
SCHLEY
MARION
CHATTAHOOCHEE
MUSCOGEE
TALBOT
TAYLOR
HOUSTON
PULASKI
LAURENS
TWIGGS
WILKINSON
JOHNSON
BIBB
CRAWFORD
UPSON
PIKE
MONROE
JONES
BALDWIN
WASHINGTON
JEFFERSON
RICHMOND
AUGUSTA
McDUFFIE
WARREN
GLASCOCK
HANCOCK
PUTNAM
MORGAN
GREENE
WILKES
LINCOLN
OGLETHORPE
WALTON
CLARKE
MADISON
ELBERT
JACKSON
BANKS
HART
HALL
GWINNETT
COBB
POLK
FLOYD
BARTOW
CHEROKEE
PICKENS
GORDON
WHITFIELD
MURRAY
FANNIN
UNION
TOWNS
RABUN
HABERSHAM
STEPHENS
HEARD
COWETA
CARROLL
CAMPBELL
HENRY
SPALDING
FAYETTE
DOUGLAS
FULTON
DeKALB
ROCKDALE
NEWTON
MORGAN
JASPER
BUTTS
MERIWETHER
TROUP
CHAMBERS
RANDOLPH
CLAY
LEE
HARRIS
MARION
SUMTER
DOOLY
WILCOX
TELFAIR
WORTH
TIFT
COFFEE
BERRIEN
LOWNDES


LEGEND.
Coal bearing strata in the county, but no coal mined in the census year.
Under 10,000 tons mined.
10,000 to 50,000 tons mined.
50,000 to 100,000 "
100,000 to 500,000 "
The figures indicate thousands of tons.
O is used in those counties, where the total output was less than 500 tons.
boundary between upper and lower coal measures.
KITTSON
MARSHALL
POLK
BELTRAMI
TASKA
LAKE
CLAY
BECKER
OTTERTAIL
CARLTON
DOUGLAS
GRANT
STEVENS
POPE
STEARNS
BENTON
SHERBURNE
ISANTI
SWIFT
CHIPPEWA
MEEKER
WRIGHT
HENNEPIN
CHISAGO
CANBY
YELLOW MEDICINE
RENVILLE
SIBLEY
SCOTT
DAKOTA
LEAU CLAIRE
LYON
REDWOOD
NICOLLET
LE SUEUR
RICE
GOODHUE
WABASH
MURRAY
COTTONWOOD
BROWN
WATONWAN
FARIBAULT
STEELE
DODGE
OLMSTED
WINONA
LACROSSE
MONROE
NOBLE
JACKSON
MARTIN
FREEBORN
MOWER
OSCEOLA
DICKSON
EMMET
KOSSUTH
WINNEBAGO
WORTH
FAYETTE
ROOSTOCK
SIOUX
O'BRIEN
CLAY
PALO ALTO
HANCOCK
MITCHELL
HOWARD
WINNESHIEK
FLOYD
CHICKASAW
CRAWFORD
PLYMOUTH
CHEROKEE
BUENA VISTA
SOUTH ORTAS
HUMBOLDT
BUTLER
GRANT
WOODBURY
IDA
SAC
CALHOUN
WEBSTER
HARDIN
GRUNDY
BUCHANAN
DELAWARE
DUBUQUE
CRAWFORD
CARROLL
GREENE
STORY
TAMA
LINN
CEDAR
CLINTON
HARRISON
SHELBY
AUDUBON
GUTHRIE
DALLAS
POLK
JASPER
IOWA
JOHNSON
SCOTT
MUSCATINE
OTTAWATTAMIE
CASS
ADAIR
MADISON
MARION
KEOKUK
WASHINGTON
MILLS
MONTGOMERY
ADAMS
UNION
CLARKE
MONROE
JEFFERSON
HENRY
DES MOINES
FREMONT
PAGE
TAYLOR
RINGGOLD
DECATUR
WAYNE
APPANOOSE
DAVIS
VAN BUREN
MISSOURI RIVER
RED RIVER OF THE NORTH
LAKE TO THE GULF
Sioux City
Des Moines
Davenport
Dubuque
Cedar Rapids
Iowa City
Muscatine
Keokuk
Marshalltown
Ames
Fort Dodge
Mason City
Red Wing
New Ulm
Winona
Lake Mills
Lake Mitchell
Lake Okoboji
Spirit Lake
Lake Pepin
Lake Winnebago
Lake Michigan
Lake Superior
Lake Erie
Lake Ontario
Lake Huron

MAP
OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County during the Census year.
SUPERIOR
LAKE
MICHIGAN
LAKE
HURON
LAKE
ERIE
MARQUETTE
SCHOOLCRAFT
OTSEGO
OSCODA
ALCONA
CRAWFORD
WALKASA
BENZIE
MANISTEE
WEXFORD
MISSAUKEE
OGEMAW
OSCO
OUTAGAMIE
BROWN
WAUSHARA
LAKE
OSCEOLA
CLARE
ISABELLA
MIDLAND
TUSCOLA
SANILAC
GRATIOT
SAGINAW
GENESEE
LAPEER
ST CLAIR
IONIA
CLINTON
OAKLAND
EATON
INGHAM
LIVINGSTON
BARRY
CALHOUN
JACKSON
WASHTENAW
KALAMAZOO
CASS
ST JOSEPH
BRANCH
HILLSDALE
LENAWEE
DODGE
DANE
RACINE
KENOSHA
WALWORTH
WAUPACA
FOND DU LAC
COLUMBIA
GREEN
ROCK
Saginaw
Lansing
Kalamazoo
Detroit
Port Huron
Sandusky
Toledo
Cleveland
Erie
Chicago
Milwaukee
Green Bay
Menominee
Marquette
Sault Ste Marie
Houghton
Ontonagon
Bayfield
Ashland
Superior
Duluth
Grand Haven
Muskegon
Manistee
Traverse City
Alpena
Thunder Bay
Saginaw Bay
Grand River
Kalamazoo River
Maumee River
Sandusky Bay
Lake St Clair
Lake Huron
Lake Michigan
Lake Superior
Lake Erie
Lake Ontario
Lake Winnebago
Lake Michigan
Lake Superior
Lake Huron


LEGEND.
Coal bearing strata in the county, but no coal mined in the census year.
Under 10,000 tons mined.
10,000 to 50,000 tons mined
50,000 to 100,000 " "
100,000 to 500,000 " "
The figures indicate thousands of tons.
O is used in those counties, where the total output was less than 500 tons.
boundary between upper and lower Coal measures
The Coal mined in Republic and Cloud Counties, Kansas, is of Cretaceous age.
The boundaries of the field are not defined.
MAP
OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County
during the Census year.
KANSAS
INDIAN TERRITORY
CUSTER
SHERMAN
HOWARD
BUFFALO
HALL
CHASE
HAYES
FRONTIER
PHELPS
KEARNEY
ADAMS
CLAY
FILLMORE
DUNDY
HITCHCOCK
RED WILLOW
FURNAS
HARLAN
FRANKLIN
WEBSTER
NUCKOLLS
THAYER
CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
CLOUD
WALLACE
GOVE
TREGO
ELLIS
ROSSELL
LINCOLN
OTTAWA
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
ELLSWORTH
SALINE
RICE
McPHERSON
HAMILTON
KEARNEY
SEQUOYAH
BUFFALO
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
FOOTE
FORD
EDWARDS
STANTON
GRANT
ARRAPAHOE
PRATT
KINGMAN
EDGWICK
KANSAS
STEVENS
SEWARD
MEADE
CLARK
COMANCHE
BARBOUR
HARPER
SUMNER
CHEYENNES AND ARRAPAHOES
WICHITAS
KIOWAS
COMANCHES
Red River



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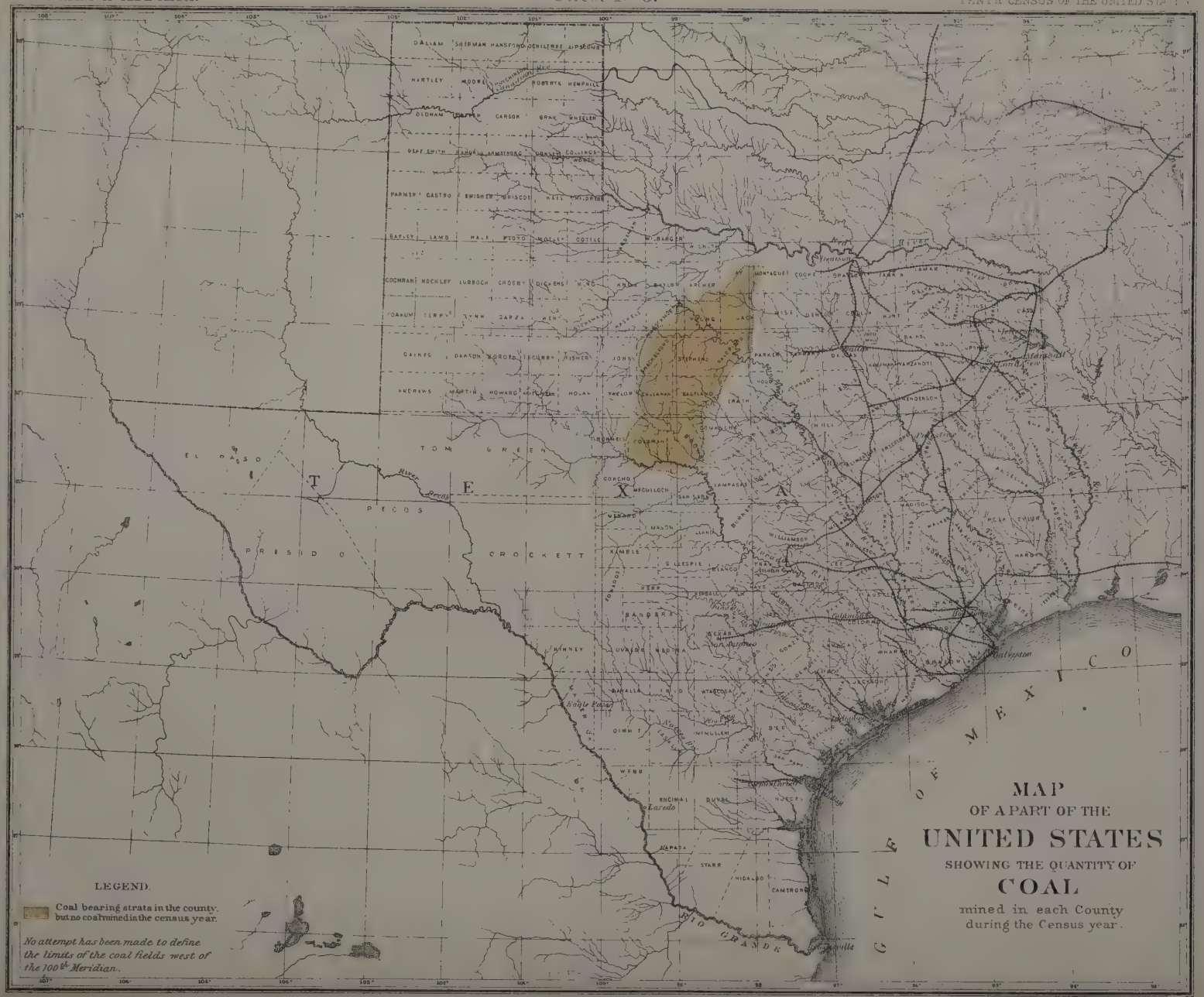

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MAP
OF A PART OF THE
UNITED STATES
SHOWING THE QUANTITY OF
COAL
mined in each County
during the Census year.
The figures indicate thousands of tons;
O is used in those counties, where the
total output was less than 500 tons.
No attempt has been made to define
the limits of the coal fields west of
the 100th Meridian.
BRITISH POSSESSIONS
PACIFIC OCEAN
WASHINGTON
MONTANA
OREGON
IDAHO
NEVADA
CALIFORNIA
WYOMING
UTAH
ARIZONA
Scale

TABLE 27.—*Production of anthracite coal, by states and counties.*

[NOTE.—With the exceptions of columns 5 and 6, in which the regular and irregular products are combined, all the questions in columns 1 to 53, both inclusive, relate to regular establishments only.]

PENNSYLVANIA.

	Counties.	Number of mines.	Maximum yearly capacity.	Acres of coal lands worked.	Acres of coal lands to be worked.	Acres of coal lands not specified.	Product of establishments, census year.	Value of product of establishments at mines.	Total product, census year, i. e., product of establishments, regular and irregular product together.	Value of total product,
		1	2	3	4	5	6	7	8	9
			Tons.				*Tons.*		*Tons.*	
	The State	275	42, 406, 897	14, 450	89, 850	64, 161	28, 612, 595	$42, 116, 500	28, 640, 819	$42, 172, 948
1	Carbon	7	1, 013, 600	1, 572	5, 292	20	808, 373	1, 365, 485	808, 597	1, 365, 933
2	Columbia	7	551, 300	20	854	692	318, 573	459, 095	318, 573	459, 095
3	Dauphin	2	634, 892	.....	.....	6, 094	450, 345	723, 766	450, 245	723, 766
4	Lackawanna	44	8, 585, 192	4, 435	26, 522	6, 243	5, 825, 316	7, 645, 450	5, 847, 716	7, 690, 250
5	Luzerne	95	18, 121, 220	6, 210	23, 395	28, 799	11, 687, 672	17, 819, 109	11, 693, 272	17, 830, 309
6	Northumberland	27	3, 095, 460	797	8, 938	7, 174	2, 099, 966	2, 958, 205	2, 099, 966	2, 958, 205
7	Schuylkill	92	10, 360, 433	1, 410	24, 784	15, 139	7, 404, 177	11, 118, 130	7, 404, 177	11, 118, 130
8	Susquehanna	1	44, 800	6	65	.....	18, 173	27, 260	18, 173	27, 260

RHODE ISLAND.

	The State	1	10, 000	.....	.....	160	6, 176	15, 440	6, 176	15, 440
1	Newport	1	10, 000	.....	.....	160	6, 176	15, 440	6, 176	15, 440

VIRGINIA.

	The State	1	70, 000	.....	.....	1, 280	2, 600	7, 800	2, 817	8, 290
1	Augusta	.....	.....	.....	.....	.....	.....	.....	112	250
2	Pulaski	1	70, 000	.....	.....	1, 280	2, 600	7, 800	2, 705	8, 040

TABLE 27.—*Production of anthracite coal, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	EMPLOYÉS. Men employed above ground.	Men employed below ground.	Boys employed above ground	Boys employed below ground.	Total employés.	Miners.	Laborers.	Administrative force.	Total wages paid.
		10	11	12	13	14	15	16	17	18
	The State	16,073	38,465	12,181	3,950	70,669	20,333	49,049	1,287	$22,664,055
1	Carbon	557	1,395	530	78	2,560	647	1,879	34	717,055
2	Columbia	259	367	187	16	829	160	648	21	255,578
3	Dauphin	218	759	201	78	1,256	369	877	10	566,994
4	Lackawanna	2,152	7,757	2,626	1,287	13,822	3,803	9,870	149	4,361,153
5	Luzerne	6,210	14,474	4,309	1,709	26,702	6,779	19,450	473	8,888,996
6	Northumberland	1,376	3,326	998	190	5,890	2,268	3,508	114	1,741,181
7	Schuylkill	5,294	10,363	3,325	587	19,569	6,292	12,793	484	6,118,224
8	Susquehanna	7	24	5	5	41	15	24	2	14,874

RHODE ISLAND—Continued.

	The State	9	22	1		32				10,300
1	Newport	9	22	1		32				10,300

VIRGINIA—Continued.

	The State	18	29			47				19,052
1	Augusta									
2	Pulaski	18	29			47				19,052

TABLE 27.—*Production of anthracite coal, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	Number of mining company's stores.	CAPITAL. Real estate.	Plant.	Working capital.	Total.	Value of all materials used.	Value of all machines.	Number of horses.	Value of horses.	Number of mules.	Value of mules.
		19	20	21	22	23	24	25	26	27	28	29
	The State	72	$105,286,444	$41,166,399	$7,946,953	$154,399,796	$6,729,477	$13,908,415	416	$49,712	8,072	$897,765
1	Carbon	3	5,007,858	1,805,796	260,500	7,074,154	286,808	438,988	7	1,050	290	35,737
2	Columbia	1	1,285,736	448,342	114,415	1,848,493	77,964	229,000	3	835	80	9,820
3	Dauphin	.....	3,066,246	1,076,549	80,000	4,222,795	114,580	234,316	7	750	246	34,325
4	Lackawanna	15	13,070,688	7,857,270	916,080	21,843,958	1,336,600	2,201,725	124	14,190	1,673	29,520
5	Luzerne	42	41,854,010	15,978,968	3,822,000	61,654,978	2,515,830	4,412,050	164	20,722	3,087	451,928
6	Northumberland	1	7,867,106	2,229,693	554,615	10,651,414	488,307	890,923	28	3,065	701	88,445
7	Schuylkill	10	33,084,800	11,763,781	2,194,423	47,043,004	1,906,388	5,502,313	83	9,600	1,986	247,315
8	Susquehanna	.....	50,000	6,000	5,000	61,000	3,000	.....	.....	.....	9	675

RHODE ISLAND—Continued.

	The State	.....	.....	.....	.....	$27,500	$2,500	.....	.....	.....	.....	.....
1	Newport	.....	.....	.....	.....	27,500	2,500	.....	.....	.....	.....	.....

VIRGINIA—Continued.

	The State	.....	.....	.....	.....	$77,040	$615	.....	.....	.....	1	50
1	Augusta	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Pulaski	.....	.....	.....	.....	77,040	615	.....	.....	.....	1	50

TABLE 27.—*Production of anthracite coal, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of unsawed lumber (for purposes other than fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Value of explosives.	Number of hoisting-machines.
		30	31	32	33	34	35	36	37	38	39	40	41
								Lin. feet.		*Feet B. M.*			
	The State	1,665	$3,817,866	105,752	4,111	$2,380,740	89,418	26,366,541	$890,334	39,525,547	$645,509	$1,622,378	606
1	Carbon	73	188,536	4,591	185	71,982	5.052	765,205	39,015	1,561,668	14,829	28,206	31
2	Columbia	31	55,100	1,819	86	48,500	1,296	410,514	12,279	438,425	6,358	11,318	6
3	Dauphin	30	88,020	1,175	94	20,700	1,880	664,700	21,276	976,315	13,566	10,917	7
4	Lackawanna	240	561,517	10,490	507	282,283	12,150	3,799,314	79,617	6,884,997	185,120	452,023	116
5	Luzerne	609	1,258,050	38,223	1,560	689,308	38,744	5,421,006	237,050	14,051,588	168,237	645,969	225
6	Northumberland	127	276,800	10,063	291	166,970	5,207	2,816,689	87,349	2,844,036	81,058	117,369	46
7	Schuylkill	555	1,389,843	39,391	1,388	1,100,997	25,089	12,473,885	413,498	12,723,518	175,891	355,326	175
8	Susquehanna	.....	.....	.....	.....	.....	.....	15,228	250	45,000	450	1,250	.....

RHODE ISLAND—Continued.

	The State	2	.....	55	5	.....	75	4,000	$70	.....	.....	$800	1
1	Newport	2	.....	55	5	.....	75	4,000	70	.....	.....	800	1

VIRGINIA—Continued.

	The State	.....	.....	.....	.....	.....	.....	5,500	$325	.....	.....	$100	.....
1	Augusta	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Pulaski	.....	.....	.....	.....	.....	.....	5,500	325	.....	.....	100	.....

TABLE 27.—*Production of anthracite coal, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	Number of mine locomotives.	Value of mine locomotives.	Number of pit-cars.	Value of pit-cars.	Miles of underground track.	Miles of outside track.	Value of ventilating machinery.	Horse-power of ventilating machinery.	Number of drainage-pumps.	Horse-power of drainage-pumps.	Value of breaking-machines.	Horse-power of breaking-machines.
		42	43	44	45	46	47	48	49	50	51	52	53
	The State	83	$251,758	31,267	$1,691,242	1,085	258	$375,586	7,214	635	40,807	$4,826,807	11,196
1	Carbon	8	18,100	1,176	66,651	44	14	8,867	158	19	2,388	141,050	255
2	Columbia	1	3,500	286	21,895	9	4	5,050	145	9	302	92,340	204
3	Dauphin	1	3,000	514	60,900	24	4	6,400	180	15	6,406	22,000	85
4	Lackawanna	9	27,258	7,787	273,530	226	44	47,010	856	103	3,017	1,177,700	2,172
5	Luzerne	32	104,600	11,865	602,132	394	89	132,100	2,987	282	14,566	1,379,000	4,070
6	Northumberland	6	17,800	2,170	137,930	117	22	28,230	631	56	2,580	402,800	1,011
7	Schuylkill	26	77,500	7,441	527,304	270	80	147,929	2,257	151	11,548	1,611,917	3,399
8	Susquehanna	.....	.....	28	900	1	1	.....	.....	.....	.....	.....	.....

RHODE ISLAND—Continued.

	The State	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
1	Newport	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....

VIRGINIA—Continued.

	The State	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	Augusta	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	Pulaski	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 27.—*Production of anthracite coal, by states and counties*—Continued.

PENNSYLVANIA—Continued.

	Counties.	Amount of culm or slack produced.	Amount subjected to washing.	ESTIMATED STATISTICS OF SMALL SURFACE MINES.								
				Number of mines.	Maximum yearly capacity.	Product, census year.	Value of product.	Number of employés.	Total wages paid.	Value of explosives.	Value of all other materials.	Total value of materials.
		54	55	56	57	58	59	60	61	62	63	64
		Tons.	*Tons.*		*Tons.*	*Tons.*						
	The State	7,060,447	1,396,806	21	50,500	28,224	$56,448	106	$21,168	$1,412	$1,412	$2,824
1	Carbon	366,914	28,185	1	500	224	448	6	168	12	12	24
2	Columbia	117,772	11,060	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Dauphin	177,255	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	Lackawanna	1,568,790	7,840	16	40,000	22,400	44,800	80	16,800	1,120	1,120	2,240
5	Luzerne	2,415,822	1,036,882	4	10,000	5,600	11,200	20	4,200	280	280	560
6	Northumberland	539,595	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	Schuylkill	1,871,499	312,839	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	Susquehanna	2,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

RHODE ISLAND—Continued.

	The State	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	Newport	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

VIRGINIA—Continued.

	The State	.....	.....	2	.....	217	490	6	305	.....	.....	.....
1	Augusta	.....	.....	1	.....	112	250	4	200	.....	.....	.....
2	Pulaski	.....	.....	1	.....	105	240	2	105	.....	.....	.....

REMARKS ON THE STATISTICS OF PENNSYLVANIA ANTHRACITE. a

Non-producing mines.—The statistics of these have been deducted from the totals, but in the case of the non-producing mines of the Philadelphia and Reading Coal and Iron Company the value of coal lands, plant, and machinery has been included in the total values of these items as returned for all the mines of that company in each county.

Tons.—All of 2,000 pounds.

Maximum capacity.—When not returned and when mine was not exhausted, has been estimated as equal to a full year's production at the rate of monthly production during the census year.

Acres.—When the answer is mixed, *i. e.*, includes both acres worked and unworked, the figures are placed in the column headed, "Number of acres not specified." None of the acres returned by the Philadelphia and Reading b Coal and Iron Company as "worked" were entirely worked out, some seams still remaining untouched. In addition to the area of coal land returned as to be worked from present collieries, there are 43,485 acres of undeveloped coal land. Of these, 26,066 are in Dauphin county, 5,200 in Lebanon county, and the balance, 12,219 acres, is distributed in Columbia, Northumberland, and Schuylkill counties. The value of these lands may be estimated at from $500 to $750 per acre, or from $21,742,500 to $32,613,750.

There were also reported for Schuylkill county 9,900 acres of undeveloped coal lands, valued at $400 per acre, equal to a total of $3,960,000. The total acreage of undeveloped coal land reported equals 53,385 acres. In some cases it has not been possible to obtain the acreage owing to the highly inclined position of the strata or the undefined limits of the coal leases. In some cases the area of the seam has been taken instead of that of the c surface. See further under "acreage of large companies."

Employés.—In some cases the "maximum" instead of the "average" number of employés was returned. Wherever there was evidence of such an error, the number has been reduced, so as to correspond to the wages paid.

Wages.—It has been assumed that in all cases the amount of bills for supplies sold to miners was deducted from the gross wages by those who filled the schedules. In two or three cases where this had evidently not been done, the original figures have been replaced by estimates. "*Wages*," therefore, represent throughout *net* wages.

Capital in real estate refers to coal land exclusively. When not obtainable it has been estimated as equal to the number of acres of coal land yet to be worked from the mine in question, valued at $500 to $750 per acre. To the total value of coal land in this region should be added the sum of $25,702,500 to $36,573,750 for undeveloped d coal lands not connected with any colliery. For the particular distribution of these lands see above under "acres." When no data for an estimate of the coal land connected with a colliery were obtainable, the value of the real estate was estimated as equal to the royalty on five full years' production at the monthly rate of production during the census year.

Working capital, when not returned, has been estimated as equal to the value of one month's "wages" and "materials". Probably two months would be nearer the truth.

Materials include explosives, fuse, lumber for props or repairs to breaker or cars, iron rails, spikes and nails, tools, and shovels and other implements, oil for lighting and lubricating, besides feed for horses and mules. When not distinctly stated that all expenditure for feed was included in the return for materials, it has been assumed that e this item was *not* included. In all such cases to the original returns for materials has been added, for feed, $9 per working month for each head (mule or horse), besides $4.50 for each idle month per head when such idleness was not prior to the opening of the colliery nor subsequent to its permanent abandonment. In cases where the returns for materials were evidently inadequate, they have been replaced by estimates made up as follows: For lumber, 5 cents per ton of coal mined; for explosives, 5½ cents per ton of coal mined; for iron, tools, &c., 5 cents a ton of coal mined; for miner's oil, $2 per working month for each miner, and to this has been added for feed as above. The coal consumed under ventilating furnaces or boilers has been excluded from materials, as the value of the labor in mining such coal, appearing under wages, already forms a part of the cost of the marketed product.

Machines include engines, boilers, hoisting, pumping, ventilating apparatus, and all the iron work of breakers.

Lumber, unsawed, returned, as a rule, in linear feet. When no lumber of any kind was returned it has been f estimated at 5 cents per ton of coal mined, and all considered as unsawed and valued from 4 to 5 cents a linear foot. When the sawed lumber has been returned but no unsawed, the latter has been estimated at 3 cents a ton of coal and valued per foot as above. When the number of feet and diameter has been given, but no value, the following scale has been used: Diameter 4 inches, value 1¾ cents per linear foot; diameter 5 inches, 2 cents per linear foot; diameter 6 inches, 2½ cents per linear foot; diameter 7 inches, 3 cents per linear foot; diameter 8 inches, 4 cents per linear foot; diameter 9 inches, 5 cents per linear foot; diameter 10 inches, 6 cents per linear foot; diameter 11 inches, 7½ cents per linear foot; diameter 12 inches, 10 cents per linear foot. The diameter is always measured at the small end. The average diameter of unsawed lumber used in the Pennsylvania anthracite region may be taken as follows: Prop timber, 8 inches to 9 inches; sills or ties, 5 inches; laggings, 3 inches; sprags, 4 inches. In addition to the amounts returned on the tables the following amounts of lumber were tabulated under "remarks",

a and not included in the totals, except of "value of unsawed lumber" and of "materials": 10,861 laggings, 1,610 cords, 204,251 mine-ties, and 2,357,381 feet board measure. (Laggings, 3 inches diameter; ties, 5 inches diameter and 6 feet in length.) All these items are estimated equal to 5,245,869 feet linear.

Lumber, sawed, returned in feet, board measure. When no value, or value without quantity, returned, has been estimated to average $20 per 1,000 feet, all kinds taken together. To the "total feet" in the columns should be added 15,000 cubic feet = 180,000 feet board measure. The value of total remaining unchanged.

Explosives, when not returned, estimated at 5½ cents per ton of coal mined.

Ventilating apparatus, value.—This includes in very many cases not only the fan but the fan inclosure.

b *Horse-power of fan*, when not returned estimated at 20 per fan.

Horse-power of pumps.—When not returned has been estimated at 100 per colliery.

Breaking machinery.—The value of a breaking-machine includes all the iron-work of the breaker, except the engine and boiler, that is, it includes the following: Breaker rolls, breaker screens, chute linings, iron-work and tracks, shafting, pulleys, etc. (leaving out the bare structure and the engine and boilers). In the majority of cases either the value of the entire breaker, building and contents, or else of the breaker rolls alone, was returned. In all such cases the value of the breaker has been arrived at by subtraction or addition, and the use of the following table (prepared by J. H. Bowden, engineer of the Susquehanna Coal Company), which purports to give close approximations to the relative cost of breakers recently built:

c

Daily capacity.	Cost of building.	Chute linings and iron-work.	Breaker rolls.	Breaker screens,	Engines, machinery, and tracks.	Total cost.
Tons.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
500	8,000	4,000	1,200	1,800	5,000	20,000
750	12,500	5,500	1,600	2,400	8,000	30,000
1,000	17,000	7,000	2,000	3,000	11,000	40,000
1,250	21,000	8,300	2,200	3,500	15,000	50,000
1,500	25,500	9,500	2,500	4,000	18,500	60,000
1,750	30,000	10,800	2,700	4,500	22,000	70,000
2,000	35,000	12,000	3,000	5,000	25,000	80,000
2,500	45,000	14,500	3,500	6,000	31,000	100,000

d *Number of collieries.*—The following definitions of a colliery have been adopted as a guide in determining the number of collieries: A colliery comprises "all the underground workings whose product is mingled in the preparation before delivery for transportation". "A colliery consists of the entire plant necessary for the mining and preparing of anthracite for market, namely, the breaker, and all mine openings, roads, etc., for supplying it." A complete breaker supplied from one or more shafts or slopes, etc., is a colliery. "One opening without a breaker is not counted a colliery." The following returns of small mines or openings which have no breakers of their own, and the product of which is probably largely broken by hand and consumed by local trade, are therefore omitted as far as they relate to the number of collieries; and their production should be deducted from the total regular product and added to that of the small surface mines in order to arrive at the exact average production of a colliery e in the proper sense:

f

County.	Number of openings.	Product, census year.	Value of same.
		Tons.	
Schuylkill	1	4,000	$8,061
Do	1	1,300	1,771
Do	1	134	200
Do	1	67	90
Do	1	634	991
Do	1	1,344	1,800
Do	1	383	769
Do	1	4,032	5,400
Do	1	840	1,800
Do	1	224	367
Do	30	5,824	9,551
Do	1	305	500
Columbia	1	2,240	2,800
Total	42	21,327	34,100

Of course the twenty-one mines or concerns producing 28,224 tons in Lackawanna, Luzerne, and Carbon counties, which amount is classified as irregular product (surface mines), are not to be considered as collieries.

Culm.—The amount, 7,060,447 tons, was returned by collieries which produced during the same time 20,295,529 tons of salable coal, that is, the culm was equal to 34$\frac{2}{10}$ per cent. of the salable product. If the remaining collieries had furnished returns of culm, the total culm would, estimated at that rate, have amounted to 9,904,884 tons.

Philadelphia and Reading Coal and Iron Company.—The returns for capital in real estate and plant of this concern were given in gross by counties, and cover the coal lands and the plants of such of their collieries as were not in operation during the census year. This affects somewhat the accuracy of these two columns. a

Acreage of large companies.—The following shows the aggregate acreage of all classes returned by the large companies: b

Name of company.	Producing mines.	Non-producing mines.
	Acres.	*Acres.*
Lehigh Valley Coal Company	2,170	.....
Lehigh and Wilkes-Barre	5,073	.....
Delaware and Hudson Canal Company	38,848	1,139
Delaware, Lackawanna and Western Railroad Company	3,783	642
Pennsylvania Coal Company	3,200	.....
Philadelphia and Reading Coal and Iron Company	39,650	1,753
Girard estate	1,697	.....
All other concerns and individuals	74,039	2,847
Total	168,460	6,381

These figures do not include the undeveloped coal lands of the Philadelphia and Reading Coal and Iron Company or of the Broad Mountain Land Company, amounting together to 53,385 acres. c

RÉSUMÉ.

	Acres.
Undeveloped	53,385
Producing mines	168,460
Non-producing mines	6,381
Total	228,226

Deficiencies.—D. Vaughan & Co., Ashland. According to Pennsylvania mine-inspector's report for 1880, their "Pioneer" colliery produced 2,373 long tons and their "Vaughan" colliery, 2,373 long tons. These returns, however, only include the "Pioneer" with a production of 2,520 short tons for census year. The concern has failed to reply to letters and telegrams on the subject. According to the same report, the Big Run Gap mine (James Fennel) produced in 1879 2,703 and in 1880 2,568 long tons. No census returns were obtained from this mine. d

T. NELSON DALE,

Special Agent to assist in the collection of Mining Statistics.

TABLE 28.—*Production of anthracite coal, by states.*

[A summary of Table 27.]

States.	Number of counties reporting.	Number of mines.	Maximum yearly capacity.	Number of acres coal lands worked.	Number of acres coal lands to be worked.	Number of acres coal lands not specified.	Product in census year.	Value at mine.
	0	1	2	3	4	5	6	7
			Tons.				*Tons.*	
Total	11	300	42,537,397	14,450	89,850	65,601	28,649,812	$42,196,678
Pennsylvania:								
Regular establishments	8	275	42,406,897	14,450	89,850	64,161	28,612,595	42,116,500
Estimated statistics of small surface mines		21	50,500				28,224	56,448
Rhode Island	1	1	10,000			160	6,176	15,440
Virginia:								
Regular establishments	1	1	70,000			1,280	2,600	7,800
Farmers' diggings	1	2					217	490

States.	EMPLOYÉS.								Total wages paid.
	Men employed above ground.	Men employed below ground.	Boys employed above ground.	Boys employed below ground.	Total employés.	Miners.	Laborers.	Administrative force.	
	8	9	10	11	12	13	14	15	16
Total	16,100	38,516	12,182	3,950	70,860	20,333	49,049	1,287	$22,714,880
Pennsylvania:									
Regular establishments	16,073	38,465	12,181	3,950	70,669	20,333	49,049	1,287	$22,664,055
Estimated statistics of small surface mines					106				21,168
Rhode Island	9	22	1		32				10,300
Virginia:									
Regular establishments	18	29			47				19,052
Farmers' diggings					6				305

States.	Number of mining company's stores.	CAPITAL.				Value of all materials used in mine.	Total value of all machines.	Number of horses.	Value of horses.	Number of mules.	Value of mules.
		Real estate.	Plant, etc.	Working capital.	Total.						
	17	18	19	20	21	22	23	24	25	26	27
Total	72	$105,286,444	$41,166,399	$7,946,953	$154,504,336	$6,735,416	$13,908,415	416	$49,712	8,073	$897,815
Pennsylvania:											
Regular establishments	72	105,286,444	41,166,399	7,946,953	154,399,796	6,729,477	13,908,415	416	49,712	8,072	897,765
Estimated statistics of small surface mines						2,824					
Rhode Island					27,500	2,500					
Virginia:											
Regular establishments					77,040	615				1	50
Farmers' diggings											

TABLE 28.—*Production of anthracite coal, by states*—Continued.

States.	STEAM-POWER. Number of steam-engines.	Value of steam-engines.	Horse-power of steam-engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Amount of unsawed lumber (for purposes other than fuel).	Value of unsawed lumber.	Amount of sawed lumber.	Value of sawed lumber.	Value of explosives.
	28	29	30	31	32	33	34	35	36	37	38
							Lin. feet.		*Feet B. M.*		
Total	1,667	$3,817,866	105,807	4,116	$2,380,740	89,493	26,376,041	$890,729	39,525,547	$645,509	$1,624,690
Pennsylvania:											
Regular establishments	1,665	3,817,866	105,752	4,111	2,380,740	89,418	26,366,541	890,334	39,525,547	645,509	1,622,378
Estimated statistics of small surface mines											a1,412
Rhode Island	2		55	5		75	4,000	70			b800
Virginia:											
Regular establishments							5,500	325			c100
Farmers' diggings											

States.	Number of hoisting-machines.	Number of mine locomotives.	Value of mine locomotives.	Number of pit-cars.	Value of pit-cars.	Miles of underground track.	Miles of outside track.
	39	40	41	42	43	44	45
Total	607	83	$251,758	31,267	$1,691,242	1,085	258
Pennsylvania:							
Regular establishments	606	83	251,758	31,267	1,691,242	1,085	258
Estimated statistics of small surface mines							
Rhode Island	d1						
Virginia:							
Regular establishments							
Farmers' diggings							

States.	Value of ventilating machinery.	Horse-power of ventilating machinery.	Number of drainage-pumps.	Horse-power of drainage-pumps.	Value of breaking-machines.	Horse-power of breaking-machines.	Amount of culm or slack produced.	Amount subjected to washing.
	46	47	48	49	50	51	52	53
							Tons.	*Tons.*
Total	$375,586	7,214	636	40,807	$4,826,807	11,196	7,060,447	1,396,806
Pennsylvania:								
Regular establishments	375,586	7,214	635	40,807	4,826,807	11,196	7,060,447	1,396,806
Estimated statistics of small surface mines								
Rhode Island			1					
Virginia:								
Regular establishments								
Farmers' diggings								

a Value of other materials, $1,412.
b Value of other materials, $1,700.
c Value of other materials, $515.
d Also 1 breaking-machine.

GENERAL ANALYSIS OF THE ANTHRACITE STATISTICS OF PENNSYLVANIA (a).

By C. F. Johnson, Jr.

The following exhibit shows the number of establishments, capacity, product, capital, number of employés, and various details under the above head of the "anthracite industry" during the census year beginning June 1, 1879, and ending May 31, 1880.

The net ton of 2,000 pounds is invariably used in this Bulletin.

ESTABLISHMENTS.

			c
Number of counties reporting	number	8	
Total number of separate establishments or collieries	do	275	
Average yearly capacity of production (per colliery)	tons	154,171	
Average actual product in census year (per colliery)	do	104,046	
Per cent. of maximum capacity attained (per colliery)	per cent	67.47	
Average capital, leased, employed, and invested (per colliery)	dollars	561,455	
Average number of hands employed (per colliery)	number	256	
Average amount of wages paid yearly (per colliery)	dollars	82,415	
Average value of materials used yearly (per colliery)	do	24,471	
Ratio of value of yearly product to total capital	per cent	27.28	
Number of company stores	number	72	

Two new counties appear as anthracite producers in the present census, viz, Lackawanna, which was set off d from Luzerne, and Susquehanna, in the southern border of which one small colliery was opened.

The number of working collieries has increased during the past ten years from 225 to 275, or 22 per cent. The average horse-power used has, however, increased from 216 to 384, or 77 per cent. The average number of hands has increased from 235 to 257, or only 9.3 per cent., while the average product per colliery has increased from 69,320 tons to 104,046 tons, a gain of 50 per cent.

The "capacity of production" referred to means the probable output, with present force and appliances, under a steady demand. The correctness of the figure is presumable from the fact that it bears about the same relation to the actual output that the time run does to the whole year.

PRODUCTION.

Merchantable product for year ending June 30, 1880	tons	28,612,595	e
Value of product delivered for transportation	dollars	42,116,500	
Average value of same per ton delivered for transportation	do	1 47	
Amount of coal washed	tons	1,396,906	
Tons raised yearly per man	do	457	
Tons raised daily per man	do	2.15	
Maximum yearly capacity of all collieries reported	do	42,406,897	

The value of the product is taken at the point where the labor we consider ceases to act on it.

A comparison of the census returns of 1880 and 1870 shows that the output has increased from 15,596,257 tons to 28,612,595 tons, or 13,016,338 tons, a gain of 84 per cent., while the gross value has increased only 10 per cent. But the value of the product of 1870 was reckoned in paper dollars. The apparent fall of the average price per ton is from $2 49 to $1 47, or $1 02, about 41 per cent., considerably more than the change of standard would account for. f

The number of tons raised yearly per man—laborers, miners, and administrative force being considered together, and two boys being reckoned the equivalent of one man for this purpose—has, however, risen from 320.5 tons to 457, a gain of 42 per cent. A portion of this increased output per man is due to more steady labor, a portion to the increased use of steam-power, and a small portion, doubtless, to the increased efficiency of the individual when unharassed by declining prices.

(a) Prepared for Census Bulletin No. 223. The figures have been corrected where necessary to make them accord with the final result.

a In addition to the merchantable product given above, 83 collieries, with a production of 20,245,529 tons, report the production of 7,060,447 tons of impure coal and dust, under the head of "culm". This would be 34.2 per cent. of their product, and would indicate a total production of 9,904,884 tons of unmerchantable coal during census year, to which no value is assigned. The best procurable estimate would show that 908,250 tons of this was used in making steam at the mines. A small unascertained portion is used in locomotives on the coal roads, and another unascertained portion is sold, for use under boilers, at the cost of transportation. A slight increase in the price of coal, or improvements in the manner of using it, may give this product a commercial value hereafter. At present it is ignored, in accordance with the usage of the trade.

EMPLOYÉS, WAGES, AND TIME.

	Number of men above ground	number	16,073
b	Number of men below ground	do	38,465
	Number of boys above ground, under 16 years of age	do	12,181
	Number of boys below ground, under 16 years of age	do	3,950
	Total employés	do	70,669
	Of whom miners number		20,333
	Of whom laborers number		49,049
	Of whom administrative force number		1,287
	Giving the same total		70,669
	Per cent. of total force, miners	per cent	28.77
	Per cent. of total force, boys	do	22.82
c	Per cent. of total force, administrative force	do	1.82
	Total wages paid	dollars	22,664,055
	Average yearly income of man	do	362 04
	Average monthly income of man (full time)	do	39 10
	Per cent. of year worked	per cent	70.69
	Per cent. of year lost by stoppages, etc	do	28.60
	Per cent. of year lost in strikes	do	0.72

As compared with the force reported in the census year of 1870, the total number has increased from 52,882 to 70,669, or 34 per cent. A large proportion of this increase, however, consists of boys who are employed as slate-pickers in the breaker buildings, the number of boys employed in the mine proper remaining almost stationary. The number of adult employés has increased 24 per cent. only, and the total number of boys, 78 per cent.

d The term "administrative" force includes foremen, mine superintendents, engineers, clerks, etc., employed about the collieries.

The total amount returned as wages is $234,094 less than in the census year of 1870, a decrease of 1 per cent.

Wages, however, in the present returns, are of course reckoned on a specie basis, but, further, they signify net wages, *i. e.*, the pay-roll, less the sum the miner is obliged to expend for powder, oil, etc.

The average yearly income of adult employés has contracted only 23 per cent., which is less than its purchasing power has increased during the same interval, without taking into account the allowance necessary to reduce the wages of 1870 to net wages.

The average monthly income is found by dividing the total sum paid for wages by the total number of months **e** worked by one man. The sum thus arrived at is slightly too high, since miners who work by the ton can find employment during part of the time the colliery is idle. For the same reason the per cent. of the year lost by enforced idleness is slightly too high, and represents in reality the time shipments were suspended.

The small proportion of the time lost in strikes, less than 1 per cent., and the short average duration of the strikes reported, show that the relations between managers and miners are more harmonious than they were ten years ago.

The per cent. of the value of the product paid for labor is now 53.81 against 59.75 ten years ago. This loss of advantage to labor is, however, apparent, not real, and is caused by the reduction of gross wages to net wages referred to above. For the same reason the cost of supplies or material consumed, measured in unit of the product, is increased from 9.34 per cent. to 15.96 per cent. The proportion of the value of the product retained for royalty, **f** interest, taxes, profits, etc., is now 30.29 per cent., and was 30.91 per cent. in 1870.

CONSUMPTION OF MATERIAL.

Linear feet of unsawed lumber	feet	26,366,541
Value of same	dollars	890,334
Feet sawed lumber (board measure)	feet	39,525,547
Value of same	dollars	645,509
Value of explosives	do	1,622,378
Total value of all materials consumed	do	6,729,477
Cost of explosives per ton merchantable product	cents	5.7
Cost of all material per ton merchantable product	do	23.5

The materials used embrace explosives, oil, candles, lumber and timber, rails, repairs of all kinds, horse and mule feed, etc., but not fuel, to which no value is given. A considerable portion of the material is paid for by the miners, on the sale of which the companies controlling the 69 supply stores referred to doubtless make a profit. The capital invested in these stores is, however, not included, the mining industry alone being considered. **a**

CAPITAL.

Number of coal lands reported	acres	168,461	
Mineral value of same, whether owned or leased	dollars	105,286,444	
Average value per acre	do	624 39	
Number of tons on which royalty reported	number	14,056,931	
Amount paid on above for royalty	dollars	3,256,308	
Average amount paid per ton for royalty	do	23 17	
Number of horses	number	416	**b**
Value of horses	dollars	49,712	
Number of mules	number	8,072	
Value of mules	dollars	897,765	
Number of steam-engines	number	1,665	
Value of engines	dollars	3,817,866	
Horse-power of engines		105,752	
Number of boilers	number	4,111	
Value of boilers	dollars	2,380,740	
Horse-power of boilers		89,418	
Number of mine locomotives	number	83	
Value	dollars	251,758	
Number of pit-cars	number	31,267	**c**
Value	dollars	1,691,242	
Miles of railroad track underground	miles	1,085	
Miles of railroad track outside	do	258	
Total value of machinery, including engines and boilers	dollars	13,908,415	
Value of plant	$41,166,399		
Value of working capital	7,946,953		
Value of real estate	105,286,444		
Total capital, real and personal		154,399,796	
Ratio of real estate to total capital	per cent	68.34	
Ratio of plant to total capital	do	26.51	
Ratio of working capital to total capital	do	5.15	
Ratio of value of annual product to total capital	do	26.86	**d**

The very large increase in capital reported ($154,399,796) over that returned in 1870 ($50,807,285) would seem to call for some explanation and justification, the more so that the capital in 1870 was reckoned in paper dollars.

The "plant" covers machinery, tracks, cars, buildings, animals, shafts, and dead work, and is the sum of the several items, and has been kept rather under than above its true value.

The largest part of the increase of capital is due to the fact that we have included in our returns the coal lands not owned by the mining companies, but worked on a royalty. Mineral lands are clearly a part of the capital of the mining industry, whether owned or leased or mortgaged. It has been our aim, however, to include only those coal lands which are in immediate connection with a working colliery, and either producing, or, in view of the increasing demand for this fuel, about to produce. The area reported would make a block only 16.12 miles square, **e** which the 1,085 miles of underground track would pierce with 67 parallel gangways from side to side, less than one-quarter of a mile apart; 53,385 acres of non-producing coal lands, valued at $25,702,500, held in reserve by the great companies, were thrown out altogether as not an element of productive wealth at present. Of the 164,852 acres retained, 13,852 were returned as worked over. As all but a very small portion of this still contains the lower seams, it has all been considered as producing coal lands. The total amount so retained constitutes about 56.68 per cent. of the entire area of anthracite lands, estimated at 290,791 acres.

The average value per acre, $624 39, is much less than the ordinary market value of such lands, so far as such property—valuable only in blocks—can be said to have a market value. The price has usually been fixed by the owners.

Again, taking the average royalty of 23.17 cents per ton, which is reported as paid on 51¼ per cent. of the **f** product returned, and extending it to the entire output, the anthracite real estate would receive a yearly income of $6,356,302. We are justified in this extension, since the lands owned are returned as equally valuable with those worked on a royalty.

Assuming the careful estimate of the total yield of the entire field made by Mr. Joseph B. Harris, based on the very conservative view that only 27 per cent. of the total content could be mined and marketed, the production of anthracite after 1880 would reach 4,009,640,000 net tons before exhaustion. This would indicate that the output of the census year could be maintained for 146 years.

a As the lands which we have assumed as a necessary part of the industrial capital to be reported constitute 56.68 per cent. of the entire area, they could continue to earn their present income for 83 years.

If we assume that one-tenth of the income would be absorbed in taxes and expenses, the present value of the above income for 83 years would be, with interest at 5 per cent., in round numbers, $112,420,000, and with interest at 5½ per cent., $102,790,000.

The above valuations would be materially increased if we took into account the probable anticipations of the payments of the income of the later years of the term, owing to the increasing demand and the probable reduction of taxes as the estate approached exhaustion.

Finally, the term "working capital" means the sum of money necessarily advanced for wages and supplies during the interval between production and the receipt of returns from sales. It is represented in actual property b by the unsold product on hand and in transit. The estimate of this amount was made in nearly all of the collieries by the operators. As the sum is equal to but little more than the value of the product for sixty days, it is evidently not exaggerated.

On the whole, therefore, the actual value of the anthracite property, as an element of productive wealth, is underestimated, notwithstanding the great apparent rise since 1870.

These considerations will apply also to our forthcoming reports on the other mineral industries, in all of which the production has nearly doubled, while the capital has increased in a much greater ratio.

c

Counties.	PRODUCTION.				Relative production—per cent. of total output, 1880.
	1880.	1870.	Gain.	Loss.	
	Tons.	*Tons.*	*Per cent.*	*Per cent.*	
Luzerne 11,687,672	17,512,988	9,519,298	84.0	.....	25.878
Lackawanna 5,825,316					40.847
Schuylkill	7,404,177	3,860,144	91.8	.....	20.359
Northumberland	2,099,966	1,001,200	109.8	.....	7.339
Carbon	808,373	403,384	100.4	.....	2.825
Dauphin	450,345	411,355	9.5	.....	1.574
Columbia	318,573	400,876	.....	20.53	1.112
Susquehanna	18,173	.....	.....	.....	0.064
Total	28,612,595	15,596,257	83.6	.....	.....

d Careful estimates prove that about 50,000 tons, in addition to the above, is raised in a small way for local consumption. As this does not enter into the merchantable product, nor affect the relations of the industry in any way, it has been omitted in the above computations.

The anthracite producers are entitled to the acknowledgments of the department for the pains they have taken in filling the census schedules, a task which, in case of the larger companies, involved a great deal of labor.

The census report of 1870 covered some coal from other fields now classed as semi-anthracite. This amount was deducted before the general comparisons were made.

STATISTICS

OF THE

PRODUCTION OF BITUMINOUS COAL AND LIGNITES IN THE CENSUS YEAR.

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties.*

GENERAL REMARKS ON THE STATISTICS OF BITUMINOUS COAL.—The following remarks apply to all the statistics of bituminous coal collected by special agents, statistics for each state will be found in their proper place. *Tons:* All of 2,000 pounds. *Maximum capacity*, when not returned, has been estimated as equal in real estate, plant, and working capital. Real estate was considered as including mineral lands only. When the working capital was not returned, it original figures have been replaced by estimates. *Wages* represent the net earnings of employés, their contributions to the mining supplies having been by operators or miners. Coal needed for fuel about the mines has not been included in "materials"; as the cost of mining it appears under "wages".

[NOTE.—With the exceptions of columns 5 and 6, in which the regular and irregular product are

ALABAMA.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
	The State	19	451,622	322,934	$475,559	323,972	$476,911	$772,858
1	De Kalb	1	3,000	3,000	5,000	3,000	5,000	3,000
2	Jackson	1	25,000	25,000	50,000	25,000	50,000	60,000
3	Jefferson	5	254,800	182,394	256,432	182,394	256,432	586,808
4	Madison	3	2,250	1,200	2,800	1,200	2,800	1,100
5	Shelby	3	109,072	95,450	133,687	95,450	133,687	107,000
6	Tuscaloosa	6	57,500	15,890	27,640	16,928	28,992	14,950

ARKANSAS.

	The State	14	57,440	14,778	$33,535	14,778	$33,535	$15,600
1	Johnson	6	47,240	11,233	22,525	11,233	22,525	13,500
2	Pope	2	3,760	1,880	6,660	1,880	6,660	100
3	Sebastian	4	6,200	1,425	2,850	1,425	2,850	1,400
4	Washington	2	240	240	1,500	240	1,500	600

GEORGIA.

	The State	2	165,000	154,644	$231,605	154,644	$231,605	$441,745
1	Dade	2	165,000	154,644	231,605	154,644	231,605	441,745

ILLINOIS.

	The State	590	13,808,709	6,089,514	$8,739,755	6,115,377	$8,779,832	$10,654,261
1	Brown	1	800	400	800	400	800	200
2	Bureau	20	169,000	65,720	115,441	65,890	115,781	123,730
3	Clinton	1	60,000	40,000	60,000	40,000	60,000	78,000
4	Coles	1	8,000	320	550	320	550	150
5	Fulton	58	586,646	331,449	413,333	336,171	419,265	380,874
6	Gallatin	3	184,400	80,400	101,150	80,400	101,150	235,300
7	Greene	2	9,000	2,200	3,150	3,260	4,770	8,787
8	Grundy	20	322,670	183,212	280,455	183,812	281,355	357,050
9	Henry	35	596,510	154,595	249,983	155,695	251,633	556,770
10	Jackson	11	339,500	64,412	100,443	64,412	100,443	268,763
11	Jasper					24	60	
12	Jersey	2	1,700	1,100	1,925	2,300	3,815	
13	Johnson	1	40,000	27,000	34,290	27,000	34,290	19,500
14	Kankakee	1	5,000	1,600	3,600	1,600	3,600	14,150
15	Knox	22	57,308	25,312	37,097	26,462	39,087	51,330
16	La Salle	30	1,507,660	714,787	1,064,123	716,487	1,067,384	1,888,162
17	Logan	1	90,000	60,000	79,000	60,000	79,000	188,500
18	Livingston	11	287,000	118,230	171,124	118,230	171,124	194,190
19	Macoupin	11	471,800	247,204	319,682	247,284	319,832	411,000
20	McDonough	21	102,550	80,514	159,110	82,304	162,696	59,600

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties.*

excluding those for the states of Arkansas, Kansas, Michigan, Missouri, and Nebraska, which were collected by enumerators. More particular explanations of the to one full year's production at the rate of the monthly production during the census year. *Capital:* In collecting the statistics this was divided into investments has been estimated as equal to one month's "wages" and "materials". *Employés:* Wherever the maximum number was returned instead of the average, the deducted. *Materials* include iron, rails, feed, lumber, oil and candles, tools and cost of sharpening the same, and powder, whether these articles were purchased

combined, all the questions in columns 1 to 29, both inclusive, relate to regular establishments only.]

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
ALABAMA.														
850	21	625	17	1,513	$328,788	5	$450	66	$6,100	12	425	20	555	
12	3	.....	.....	15	4,000	.....	.....	.....	.....	.....	.....	.....	.....	1
85	3	35	5	128	29,000	.....	.....	.....	.....	.....	.....	.....	.....	2
442	9	419	5	875	187,371	4	375	40	3,600	7	225	11	295	3
29	.....	6	7	42	1,776	.....	.....	.....	.....	.....	.....	.....	.....	4
222	5	151	.....	378	98,096	1	75	15	1,500	4	160	7	220	5
60	1	14	.....	75	17,545	.....	.....	11	1,000	1	40	2	40	6
ARKANSAS.														
98	2	22	8	130	$20,850	.....	.....	.....	.....	3	35	1	.....	
66	.....	15	7	88	16,700	.....	.....	.....	.....	3	35	1	.....	1
18	2	2	.....	22	2,200	.....	.....	.....	.....	.....	.....	.....	.....	2
10	.....	3	1	14	1,350	.....	.....	.....	.....	.....	.....	.....	.....	3
4	.....	2	.....	6	600	.....	.....	.....	.....	.....	.....	.....	.....	4
GEORGIA.														
185	.....	257	.....	442	$85,179	.....	.....	34	$2,040	.....	.....	1	20	
185	.....	257	.....	442	85,179	.....	.....	34	2,040	.....	.....	1	20	1
ILLINOIS.														
13,128	950	2,152	71	16,301	$6,035,919	426	$28,675	1,078	$77,716	286	8,294	345	9,925	
3	.....	.....	.....	3	582	.....	.....	.....	.....	.....	.....	.....	.....	1
197	11	25	1	234	75,878	10	775	12	1,300	5	292	7	317	2
63	2	10	.....	75	38,605	3	400	6	500	2	75	4	375	3
3	.....	1	.....	4	400	.....	.....	.....	.....	.....	.....	.....	.....	4
602	24	133	9	768	252,336	41	3,240	51	3,560	12	229	14	315	5
179	5	38	.....	222	63,200	13	1,100	12	650	2	120	4	400	6
11	.....	2	.....	13	1,750	.....	.....	.....	.....	1	60	1	35	7
420	7	83	5	515	236,139	17	830	24	1,300	9	160	11	290	8
480	23	67	2	572	169,619	10	780	36	2,750	14	282	19	531	9
192	6	51	.....	249	54,780	7	500	27	2,008	7	160	9	175	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11
5	.....	.....	.....	5	1,100	.....	.....	.....	.....	.....	.....	.....	.....	12
64	4	16	.....	84	25,000	2	150	10	470	.....	.....	1	20	13
10	.....	1	.....	11	2,130	1	40	.....	.....	.....	.....	1	6	14
95	3	19	.....	117	20,837	6	550	.....	.....	2	35	2	35	15
1,792	146	250	11	2,199	750,711	29	2,070	131	9,315	43	1,050	42	1,300	16
95	3	15	.....	113	54,000	.....	.....	13	350	3	40	4	200	17
236	7	46	.....	289	126,977	12	800	14	900	9	290	11	350	18
464	12	52	.....	528	242,653	7	320	19	1,850	10	325	14	917	19
285	10	18	.....	313	105,085	3	200	.....	.....	4	65	4	85	20

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ALABAMA.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	13	11	$11,100	$37,483	$48,583	212	561,500	
1	De Kalb		1		240	240			
2	Jackson			1,000	1,000	2,000	200		
3	Jefferson	7	3	760	24,240	25,000		330,000	
4	Madison				96	96			
5	Shelby	4	5	9,340	10,180	19,520		228,000	
6	Tuscaloosa	2	2		1,727	1,727	12	3,500	

ARKANSAS.

	The State	7	5	$25	$1,110	$1,135	54		
1	Johnson	2	2		965	965	4		
2	Pope	1							
3	Sebastian				100	100	50		
4	Washington	4	3	25	45	70			

GEORGIA.

	The State	1	1	$3,775	$5,725	$9,500	658		
1	Dade	1	1	3,775	5,725	9,500	658		

ILLINOIS.

	The State	393	175	$267,730	$528,419	$796,149	2,439	15,299,053	484,000
1	Brown				80	80		8,000	
2	Bureau	13	6	3,487	8,391	11,878	6	61,500	
3	Clinton	1	1	875	10,000	10,875		107,500	20,000
4	Coles			10	240	250			
5	Fulton	18	9	25,057	19,862	44,919	10	488,750	
6	Gallatin	1	2	5,380	4,220	9,600		45,900	16,000
7	Greene	1			600	600			
8	Grundy	20	7	419	23,521	23,940	55	938,000	
9	Henry	16	25	6,619	11,882	18,501	50	231,000	
10	Jackson	8	5	173	8,523	8,696		78,500	
11	Jasper								
12	Jersey								
13	Johnson		1	1,080	1,000	2,080		27,000	
14	Kankakee	1	1		128	128			
15	Knox	9	3	1,579	2,082	3,661	4	70,000	
16	La Salle	52	13	14,396	82,448	96,844	26	1,381,750	220,000
17	Logan	1	2	4,400	4,900	9,300			
18	Livingston	13	4	3,255	10,430	13,685		533,500	
19	Macoupin	12	2	8,516	12,267	20,783	100	77,300	
20	McDonough	9	3		6,801	6,801		252,500	

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ALABAMA.

FARMERS' DIGGINGS.						
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
7	1,038	$1,352	20	$925	*Wages:* Deductions made for miners' oil, at $1 per month per miner. *Materials:* To total may be added $214, for one-half feed of horses and mules during idle time of mines temporarily suspending work during census year.	
						1
						2
						3
						4
						5
7	1,038	1,352	20	925		

ARKANSAS.

						1
						2
						3
						4

GEORGIA.

						1

ILLINOIS.

165	25,863	$40,077	262	$25,761	The statistics for this state were taken by Professor W. B. Potter, of Saint Louis, and Mr. W. L. Fawcett, of Chicago. The following counties are in Professor Potter's district: Clinton, Coles, Gallatin, Greene, Jackson, Jasper, Jersey, Johnson, Marion, Macoupin, Madison, Montgomery, Perry, Randolph, Saint Clair, Saline, Shelby, Washington, Williamson. All the rest are in Mr. Fawcett's. *Capital, real estate,* when not returned, has been estimated as equal to the acreage multiplied by the average value of land for the county, as given by the special agent. In taking the acreage for this estimate, Mr. Fawcett appears to have generally taken the total acres, worked and unworked. *Materials:* "The amount returned as materials represents all the materials purchased by operator or miner, and includes, as far as was possible, feed for horses and mules"—(W. B. Potter). Whenever the amount so returned for materials was not large enough to include feed, the latter was added to it at the rate of $4 per head per working month. In Mr. Fawcett's district feed was almost always omitted, and was therefore added at the above rate. To the total materials for the state may be added $7,968 for half feed of horses and mules during idle time in the case of mines temporarily suspending operations during the census year. *Wages:* "In the coal schedules the answer regarding wages means net wages, except where otherwise specified"—(W. B. Potter). The original answers have therefore been left unaltered in that district. "All figures of wages in schedules sent by me represent the gross total amount of wages paid by the mine-operator; from this amount should be deducted the cost of oil and powder to arrive at net wages. The rule is without exception throughout Iowa and Illinois that the miners (and all other laborers below ground) buy their own oil and powder. The consumption of lighting oil averages one gallon per month per man employed under ground, at an average cost of $1 per gallon"—(W. L. Fawcett). Therefore the value of all the powder and oil, at $1 per underground miner and laborer per month, has been deducted from the original returns for wages in Mr. Fawcett's district. Throughout Mr. Fawcett's district, and very probably, also, Mr. Potter's, no deduction has been made from wages for blacksmithing paid by miners. *Unsawed lumber:* The returns were generally made in "props" instead of feet linear. The number of props has been multiplied by five when the thickness of the seam was 5 feet or less, and when over by the exact thickness of the seam, in order to arrive at the linear feet of unsawed lumber used. When the lumber was returned without value, or *vice versa,* it has been estimated at one cent a foot. When lumber was used, but not returned in any shape, it has been estimated at 2 feet linear per ton of coal mined. To total unsawed lumber for the state add 34 cords without changing the value.	1
2	170	340	3	300		2
						3
39	4,722	5,932	41	4,249		4
						5
7	1,060	1,620	10	1,035		6
2	600	900	6	480		7
5	1,100	1,650	10	880		8
						9
						10
1	24	60	1	36		11
8	1,200	1,890	13	1,200		12
						13
						14
5	1,150	1,990	14	1,460		15
15	1,700	3,261	24	2,105		16
						17
						18
1	80	150	1	120		19
11	1,790	3,586	16	2,250		20

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ILLINOIS—Continued.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Values of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
21	McLean	1	150,000	63,000	113,400	63,000	113,400	94,873
22	Madison	35	684,150	272,927	413,962	273,807	415,282	391,727
23	Marion	2	54,480	39,943	45,497	39,943	45,497	93,553
24	Marshall	3	12,200	2,700	4,275	5,450	9,536	1,450
25	Menard	7	111,250	61,120	78,930	61,120	78,930	103,630
26	Mercer	12	112,900	78,741	130,149	79,531	131,180	118,810
27	Montgomery	1	100,000	42,400	74,200	42,400	74,200	62,000
28	Morgan	2	42,250	13,500	19,065	13,500	19,065	53,000
29	Peoria	49	677,610	273,540	402,234	273,640	402,384	367,725
30	Perry	12	451,900	222,186	227,343	222,186	227,343	239,260
31	Randolph	10	356,200	69,958	81,572	69,958	81,572	160,202
32	Rock Island	27	453,042	236,652	474,117	237,589	476,016	308,400
33	Saline	1	24,000	2,000	3,000	2,320	3,480	9,500
34	Sangamon	9	1,076,000	427,619	575,799	427,619	575,799	537,295
35	Schuyler	4	13,350	4,065	6,274	5,115	7,849	4,550
36	Scott	2	9,550	5,700	9,975	5,700	9,975	11,000
37	Shelby	7	20,200	6,504	13,150	6,504	13,150	9,095
38	Stark	13	54,150	21,103	27,568	22,143	28,868	30,639
39	Saint Clair	73	2,951,700	956,265	1,186,909	956,265	1,186,909	1,575,214
40	Tazewell	14	151,744	61,348	91,922	61,348	91,922	125,925
41	Vermilion	36	358,480	225,950	301,968	228,850	305,400	301,900
42	Warren	19	56,750	13,967	23,782	15,467	26,032	24,175
43	Washington	1	12,000	4,000	6,000	4,000	6,000	13,000
44	Will	5	773,259	611,311	984,908	611,311	984,908	910,782
45	Williamson	2	118,000	73,500	73,500	73,500	73,500	94,000
46	Woodford	1	150,000	101,060	175,000	101,060	175,000	175,000

INDIANA.

	The State	216	3,110,983	1,449,496	$2,143,093	1,454,327	$2,150,258	$2,304,720
1	Clay	41	1,414,085	772,423	1,229,629	772,423	1,229,629	1,269,569
2	Daviess	14	318,350	167,225	232,535	167,225	232,535	248,865
3	Dubois	8	21,520	619	1,343	619	1,343	221
4	Fountain	4	205,200	196,618	234,977	196,618	234,977	86,205
5	Gibson	1	3,500	600	900	600	900	610
6	Greene	26	56,698	7,286	12,250	7,286	12,250	3,125
7	Knox	3	60,500	48,270	65,731	48,270	65,731	26,775
8	Martin	6	24,600	1,857	3,931	1,857	3,931	4,993
9	Owen	20	50,865	3,248	4,947	3,248	4,947	3,535
10	Parke	6	157,000	70,693	94,759	70,693	94,759	184,658
11	Perry	8	44,358	9,393	16,555	10,257	18,107	67,150
12	Pike	25	84,585	12,831	18,242	12,831	18,242	24,380
13	Spencer	7	18,635	6,541	7,433	8,093	9,608	21,445
14	Sullivan	19	194,184	29,078	41,900	29,078	41,900	46,695
15	Vanderburg	2	111,232	40,607	67,016	40,607	67,016	136,000
16	Vermillion	2	40,000	9,725	10,514	9,725	10,514	10,600
17	Vigo	13	99,217	33,818	50,389	33,818	50,389	51,303
18	Warrick	8	187,404	36,174	44,712	38,550	48,150	106,424
19	Warren	8	19,050	2,490	5,330	2,490	5,330	11,565

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ILLINOIS——Continued.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	40	21	
160	.....	26	.....	186	85,330	1	75	6	450	2	80	4	150	21
654	62	91	1	808	262,168	60	2,910	33	2,985	12	430	15	343	22
68	1	12	.....	81	31,685	.....	.....	7	393	5	95	3	155	23
11	.....	.....	.....	11	2,856	.....	.....	.....	.....	.....	.....	.....	.....	24
99	1	24	.....	124	59,699	4	190	12	450	4	72	5	72	25
159	10	39	2	210	75,832	5	225	13	750	3	77	3	112	26
123	15	18	1	157	65,193	.....	.....	17	600	2	140	4	84	27
21	6	8	.....	35	12,693	2	100	1	100	1	30	1	40	28
514	16	84	4	618	239,167	19	1,150	69	5,560	3	65	6	105	29
396	21	87	3	507	165,998	3	210	76	5,270	10	255	17	249	30
114	1	21	.....	136	49,318	9	200	8	545	2	70	3	64	31
623	29	129	4	785	265,049	17	1,225	46	2,600	12	353	17	503	32
19	.....	4	1	24	2,000	.....	.....	4	200	.....	.....	.....	.....	33
610	57	119	5	791	382,282	16	1,460	68	4,435	20	625	16	702	34
10	.....	3	.....	13	3,512	2	100	.....	.....	.....	.....	.....	.....	35
18	.....	4	.....	22	7,920	.....	.....	.....	.....	1	20	1	20	36
37	2	5	.....	44	8,710	8	400	.....	.....	.....	.....	.....	.....	37
65	1	11	1	78	18,642	3	90	.....	.....	1	15	1	15	38
1,904	195	204	9	2,312	867,231	41	2,465	148	10,805	57	1,971	66	1,572	39
164	3	32	.....	199	63,949	15	1,225	13	975	3	100	4	140	40
463	45	101	.....	609	208,031	37	2,495	30	2,005	3	110	2	145	41
67	2	5	.....	74	14,667	4	125	.....	.....	.....	.....	1	10	42
6	.....	2	.....	8	3,500	.....	.....	.....	.....	.....	25	1	15	43
1,214	220	247	12	1,693	740,726	14	1,500	121	7,700	18	408	20	428	44
138	.....	22	.....	160	56,004	3	375	12	1,440	2	50	3	90	45
275	.....	27	.....	302	121,975	2	400	39	5,500	2	120	4	160	46

INDIANA.

3,748	171	570	7	4,496	$1,405,164	67	$3,635	341	$18,502	65	1,717	78	2,729	
2,061	100	280	1	2,442	785,451	24	1,395	144	7,350	38	1,104	49	1,716	1
455	20	44	.....	519	162,113	11	700	54	3,827	8	187	7	312	2
10	.....	.....	.....	10	428	.....	.....	.....	.....	.....	.....	.....	.....	3
299	6	29	.....	334	176,195	1	75	23	1,900	3	40	4	80	4
3	.....	.....	.....	3	635	1	10	.....	.....	.....	.....	.....	.....	5
68	.....	6	.....	74	6,186	.....	.....	.....	.....	.....	.....	.....	.....	6
101	5	13	.....	119	51,395	.....	.....	18	540	.....	.....	1	8	7
20	.....	2	.....	22	1,608	.....	.....	.....	.....	.....	.....	.....	.....	8
37	.....	4	.....	41	3,384	.....	.....	.....	.....	.....	.....	.....	.....	9
142	17	28	.....	187	51,545	1	50	22	1,025	.....	.....	2	22	10
24	4	18	2	48	9,226	.....	.....	12	600	.....	.....	.....	.....	11
48	.....	25	1	74	10,158	2	125	1	10	1	5	1	10	12
20	.....	3	1	24	5,661	1	50	.....	.....	.....	.....	.....	.....	13
108	4	25	.....	137	25,381	9	390	3	175	4	76	2	130	14
90	6	17	.....	113	40,362	1	60	18	710	3	130	3	170	15
35	.....	7	1	43	6,679	.....	.....	7	500	.....	.....	.....	.....	16
97	1	27	1	126	37,266	6	235	7	320	3	70	4	174	17
109	6	37	.....	152	29,291	7	425	32	1,545	4	98	4	98	18
21	2	5	.....	28	2,260	3	140	.....	.....	1	7	1	7	19

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ILLINOIS—Continued.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
21	McLean	2	1	$750	$5,036	$5,786		480,000	
22	Madison	35	5	9,929	14,633	24,562	56	148,200	
23	Marion	3		2,573	2,180	4,753		135,800	
24	Marshall			135	120	255		4,500	
25	Menard	6	1	5,471	8,120	13,591		70,100	
26	Mercer	9	7	9,466	7,892	17,358		295,000	
27	Montgomery	2	3	3,600	6,700	10,300		252,000	
28	Morgan	2	1		1,137	1,137		84,000	
29	Peoria	7	8	32,128	21,281	53,409		685,750	
30	Perry	10	5	8,741	13,843	22,584		340,399	
31	Randolph	9		5,010	1,418	6,428		93,300	
32	Rock Island	19	11	18,444	33,071	51,515		1,384,000	24,000
33	Saline			720	648	1,368		25,000	
34	Sangamon	13	8	41,742	26,685	68,427		629,400	
35	Schuyler		2	595	317	912		6,600	
36	Scott	1			285	285		25,000	
37	Shelby		4		957	957		12,500	
38	Stark	6		1,752	2,049	3,801	81	59,750	
39	Saint Clair	73	9	31,891	45,711	77,602	45	2,255,000	185,000
40	Tazewell	11	4	7,222	4,753	11,975		126,500	
41	Vermilion	15	4	9,035	16,653	25,688		506,150	
42	Warren	3	2	245	810	1,055	6	8,000	
43	Washington	1		385	115	500			
44	Will	7	15	650	94,130	94,780	1,000	3,255,904	19,000
45	Williamson	2	1	2,000	2,500	4,500		100,000	
46	Woodford	2			10,000	10,000	1,000		

INDIANA.

	The State	73	79	$56,151	$102,453	$158,604	155	2,736,749	1,290,683
1	Clay	31	46	27,595	52,082	79,677		1,630,440	886,533
2	Daviess	8	7	3,933	14,006	17,939	1	393,834	223,600
3	Dubois			20	41	61			
4	Fountain	2	2	7,811	9,694	17,505		217,150	13,600
5	Gibson			50	42	92			
6	Greene	5	2	132	502	634	52		
7	Knox			8	2,624	2,632		108,000	20,000
8	Martin			7	240	247	7		
9	Owen		1	70	280	350	13		
10	Parke		2	4,059	7,823	11,882		134,350	12,000
11	Perry			72	672	744		12,375	
12	Pike	3	3	624	1,233	1,857	20	5,600	
13	Spencer		1	90	385	475	2	7,300	
14	Sullivan	6	5	1,066	1,388	2,454	7	49,500	14,000
15	Vanderburg	2	2	4,975	4,596	9,571		36,800	62,000
16	Vermillion		1	610	1,975	2,585		7,000	5,000
17	Vigo	5	5	2,141	1,922	4,063	1	81,900	27,750
18	Warrick	7	2	2,848	2,613	5,461		52,500	26,200
19	Warren	4		40	335	375	52		

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

ILLINOIS—Continued.

FARMERS' DIGGINGS. Number of diggings.	Product census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
						21
4	880	$1,320	8	$830		22
						23
20	2,750	5,261	24	3,520		24
						25
4	790	1,031	8	550		26
						27
						28
1	100	150	1	67		29
						30
						31
7	937	1,899	19	762		32
1	320	480	4	230		33
						34
4	1,050	1,575	8	1,050		35
						36
						37
7	1,040	1,300	10	1,080		38
						39
						40
12	2,900	3,432	23	2,357		41
9	1,500	2,250	12	1,200		42
						43
						44
						45
						46

INDIANA.

	4,831	$7,165	47	$3,850		
					Capital, real estate, when not returned, has been estimated on the basis of the value of unworked coal lands connected with each mine. The following valuation per acre has been used: Clay county, $175; Fountain, Daviess, Parke, Vanderburg, and all counties where coal is shipped by rail, $150; all counties not accessible to railroads, $50 per acre.	1
						2
						3
					Wages: When the data for rectifying the returns have not been returned, the following deductions have been made from gross wages: 3 cents per ton of coal mined (1 cent for oil and 2 cents for blacksmithing) and 80 per cent. of the weight of powder returned, taken at 14 cents a pound, the price paid for it by the miners.	4
						5
					Materials: To arrive at these, there have been added to powder and lumber 1 cent per ton of coal for miner's oil, and $4 per working month for each mule or horse. To the total "materials" for the state may be added $2,476 for one-half feed of mules and horses during idle months.	6
					Lumber: In addition to the 155 cords returned for fuel, 106 cords for various uses were reported, making the total 261 cords. Of the amount of unsawed lumber reported, it is estimated that 1,512,569 linear feet averaged 6 inches in diameter, and 1,224,180 linear feet averaged 9 inches in diameter. This is based on the fact that for seams 4 feet and less in thickness 6-inch props are generally used, while for those of greater thickness 8-inch and 10-inch props are commonly employed.	7
						8
						9
						10
	861	1,552	8	650		11
						12
	1,552	2,175	15	1,250		13
						14
						15
						16
						17
	2,415	3,438	24	1,950		18
						19

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

IOWA.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments.	Value of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
	The State	227	3,896,895	1,442,338	$2,473,155	1,461,116	$2,507,453	$2,778,937
1	Adams	9	19,000	8,187	21,079	8,187	21,079	14,000
2	Appanoose	15	186,495	59,100	88,920	59,100	88,920	108,741
3	Boone	10	366,900	136,500	269,100	140,000	276,100	248,300
4	Dallas	1	40,000	8,000	31,500	13,200	42,100	92,000
5	Davis	2	6,700	5,500	8,250	5,500	8,250	5,800
6	Greene	3	46,000	8,559	15,618	8,559	15,618	102,400
7	Hamilton	1	4,500	3,000	6,000	3,000	6,000	2,500
8	Hardin	4	8,000	3,135	8,547	3,135	8,547	5,850
9	Jasper	21	185,750	74,462	126,912	74,462	126,912	133,615
10	Jefferson	12	76,210	46,150	76,550	46,150	76,550	92,880
11	Keokuk	12	281,300	48,830	83,199	49,350	84,199	128,778
12	Lee	1	1,000	500	800	500	800	1,950
13	Lucas	4	201,980	126,013	200,584	126,498	202,039	133,138
14	Mahaska	27	824,950	283,836	398,275	283,901	398,450	695,167
15	Marion	18	207,700	67,857	100,542	72,550	106,720	80,870
16	Monroe	10	306,500	181,288	291,961	181,288	291,961	155,941
17	Page	3	10,800	5,200	15,225	5,200	15,225	6,920
18	Polk	10	302,500	129,062	258,015	131,362	262,615	292,225
19	Scott	5	32,400	14,500	25,375	14,500	25,375	58,900
20	Taylor	3	3,900	2,400	6,140	2,400	6,140	1,440
21	Van Buren	3	19,800	13,890	22,833	13,890	22,833	29,087
22	Wapello	18	232,250	67,475	102,777	67,555	102,917	80,255
23	Warren	14	62,810	17,957	33,904	17,957	33,904	35,200
24	Wayne	2	10,000	6,000	12,000	6,000	12,000	7,430
25	Webster	19	459,450	124,912	269,049	126,712	272,199	264,650

KANSAS.

	The State	189	1,140,518	763,597	$1,498,168	771,442	$1,517,444	$767,994
1	Atchison					900	1,800	
2	Bourbon	51	434,430	403,519	618,570	405,416	622,098	68,025
3	Brown	1	400	400	1,800	400	1,800	2,000
4	Chautauqua	4	1,400	700	2,375	700	2,375	1,400
5	Cherokee	15	113,100	77,320	193,880	78,920	197,080	10,825
6	Cloud	8	8,400	8,500	a 20,800	8,500	20,800	6,750
7	Coffey	4	23,338	2,163	4,326	2,163	4,326	1,000
8	Crawford	19	37,880	36,450	64,015	36,450	64,015	40,200
9	Douglass	1	240	240	900	240	900	150
10	Franklin	13	20,360	14,300	38,725	15,200	40,800	11,250
11	Greenwood	1	1,200	600	3,600	600	3,600	1,800
12	Jefferson					575	2,156	
13	Labette	9	6,340	3,260	6,445	3,260	6,445	1,150
14	Leavenworth	2	122,000	60,588	121,176	60,588	121,176	360,500
15	Linn	8	13,700	11,740	18,550	11,740	18,550	3,435
16	Montgomery	1	450	375	890	481	1,488	1,200
17	Nemaha					270	1,125	
18	Neosho	2	1,000	700	1,750	700	1,750	3,000
19	Osage	38	345,460	129,492	354,191	129,832	355,821	291,739
20	Pottawatomie					120	300	
21	Republic	1	600	400	1,050	446	1,142	1,000
22	Shawnee	9	9,380	12,490	42,825	12,490	42,825	22,400
23	Wilson					540	1,275	
24	Woodson	2	840	360	1,400	911	2,897	120

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

IOWA.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
3,994	210	808	12	5,024	$1,554,696	179	$10,925	338	$23,723	57	1,445	54	1,932	
84	5	11	.....	100	17,719	8	330	.....	.....	.....	.....	.....	.....	1
194	1	38	.....	233	63,253	7	280	7	295	4	63	3	85	2
418	45	103	1	567	179,541	20	985	32	1,975	7	190	7	245	3
30	.....	8	.....	38	19,230	.....	.....	3	200	1	40	1	60	4
11	.....	3	.....	14	5,593	.....	.....	.....	.....	.....	.....	.....	.....	5
36	.....	9	.....	45	10,587	4	350	.....	.....	1	20	2	90	6
5	.....	1	.....	6	3,600	.....	.....	.....	.....	.....	.....	.....	.....	7
23	3	10	1	37	5,493	1	40	2	80	1	6	1	8	8
168	4	45	.....	217	81,976	5	290	6	365	8	146	8	215	9
163	2	30	.....	195	54,318	11	440	15	1,080	2	40	2	65	10
183	18	25	.....	226	40,442	12	630	9	720	2	80	2	85	11
1	.....	1	.....	2	494	2	150	.....	.....	.....	.....	.....	.....	12
250	7	40	.....	297	123,168	.....	.....	53	3,855	3	90	3	120	13
707	39	138	1	885	246,240	20	1,035	56	3,993	14	327	9	334	14
163	13	51	.....	227	65,637	6	280	26	1,450	.....	.....	.....	.....	15
392	7	63	1	463	185,248	35	3,330	37	2,025	5	143	4	210	16
43	.....	6	.....	49	11,392	4	160	.....	.....	.....	.....	.....	.....	17
427	29	94	2	552	160,061	14	1,215	44	3,525	5	165	7	245	18
73	3	11	.....	87	20,652	6	240	1	40	.....	.....	.....	.....	19
18	.....	2	.....	20	5,665	1	40	.....	.....	.....	.....	.....	.....	20
36	1	11	.....	48	12,575	3	140	6	800	.....	.....	.....	.....	21
130	10	28	.....	168	66,945	10	570	13	1,120	1	10	1	20	22
72	1	10	1	84	19,984	8	340	6	220	.....	.....	.....	.....	23
21	.....	6	.....	27	6,734	2	80	.....	.....	.....	.....	.....	.....	24
346	22	64	5	437	139,149	.....	.....	22	1,980	3	125	4	150	25

KANSAS.

3,142	181	288	6	3,617	$758,980	.....	.....	.....	.....	4	120	5	.....	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1,104	.....	90	.....	1,194	295,463	.....	.....	.....	.....	.....	.....	.....	.....	2
4	.....	.....	.....	4	300	.....	.....	.....	.....	.....	.....	.....	.....	3
28	.....	.....	.....	28	975	.....	.....	.....	.....	.....	.....	.....	.....	4
127	.....	18	.....	145	77,750	.....	.....	.....	.....	.....	.....	.....	.....	5
56	.....	9	1	66	13,000	.....	.....	.....	.....	.....	.....	.....	.....	6
15	.....	.....	.....	15	2,163	.....	.....	.....	.....	.....	.....	.....	.....	7
563	.....	43	.....	606	27,965	.....	.....	.....	.....	.....	.....	.....	.....	8
4	.....	2	.....	6	600	.....	.....	.....	.....	.....	.....	.....	.....	9
88	4	25	.....	117	14,750	.....	.....	.....	.....	.....	.....	.....	.....	10
26	.....	.....	.....	26	1,500	.....	.....	.....	.....	.....	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12
58	.....	.....	.....	58	3,460	.....	.....	.....	.....	.....	.....	.....	.....	13
253	50	21	.....	324	85,000	.....	.....	.....	.....	4	120	5	.....	14
30	.....	.....	1	31	12,140	.....	.....	.....	.....	.....	.....	.....	.....	15
2	.....	.....	.....	2	500	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
13	.....	13	.....	26	700	.....	.....	.....	.....	.....	.....	.....	.....	18
698	123	55	3	879	201,519	.....	.....	.....	.....	.....	.....	.....	.....	19
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20
2	.....	1	.....	3	900	.....	.....	.....	.....	.....	.....	.....	.....	21
64	4	11	1	80	19,800	.....	.....	.....	.....	.....	.....	.....	.....	22
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
7	.....	.....	.....	7	495	.....	.....	.....	.....	.....	.....	.....	.....	24

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

IOWA.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	141	56	$116,970	$132,850	$249,820		3,743,100	19,250
1	Adams	9			1,189	1,189		27,000	
2	Appanoose	12	2	12	4,725	4,737		197,000	
3	Boone	10	3	6,877	13,210	20,087		501,000	
4	Dallas	1		1,500	1,600	3,100		20,000	
5	Davis			504	286	790		40,000	
6	Greene	3	3	400	650	1,050		28,500	
7	Hamilton				250	250		6,000	
8	Hardin	2	3	235	688	923		33,250	
9	Jasper	11	10	2,966	10,338	13,304		413,550	
10	Jefferson	10	2	2,916	3,896	6,812		103,500	
11	Keokuk	11	2	2,907	4,436	7,343		111,600	
12	Lee				150	150			
13	Lucas	2	1	16,200	17,775	33,975		443,500	
14	Mahaska	20	14	27,549	14,929	42,478		472,650	19,250
15	Marion		4	6,529	4,579	11,168		96,500	
16	Monroe	12		21,761	21,315	43,076		236,500	
17	Page	4			678	678		45,000	
18	Polk	8	7	13,109	10,314	23,423		306,500	
19	Scott	5	2		1,663	1,663		82,000	
20	Taylor	1			318	318		25,000	
21	Van Buren	3		2,272	433	2,705		83,750	
22	Wapello	8		6,246	8,235	14,481		250,650	
23	Warren	6		1,554	2,316	3,870		96,500	
24	Wayne			858	366	1,224			
25	Webster	3	3	2,575	8,511	11,086		173,150	

KANSAS.

	The State	59	26	$12,125	$35,360	$47,485	947		
1	Atchison								
2	Bourbon				15,041	15,041			
3	Brown			70	300	370			
4	Chautauqua			68	142	210			
5	Cherokee	4	4	5,985	1,637	7,622	80		
6	Cloud	8	6		964	964	63		
7	Coffey				415	415			
8	Crawford			3,975	1,799	5,774			
9	Douglas	1			10	10			
10	Franklin	3		280	1,055	1,335	50		
11	Greenwood			100	100	200	10		
12	Jefferson								
13	Labette		4	60	330	390			
14	Leavenworth	2							
15	Linn	2	2	33	250	283			
16	Montgomery				6	6			
17	Nemaha								
18	Neosho				18	18			
19	Osage	25		1,409	11,332	12,741	657		
20	Pottawatomie								
21	Republic			10	115	125	15		
22	Shawnee	14	10	135	1,792	1,927	72		
23	Wilson								
24	Woodson				54	54			

TABLE 20.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

IOWA.

FARMERS' DIGGINGS.					Remarks.	
Number of diggings.	Product census year.	Value of product.	Number of persons employed.	Wages paid.		
30	31	32	33	34		
	Tons.					
68	18,783	$34,298	148	$25,145	All the remarks referring to that portion of Illinois comprised in Mr. Fawcett's district apply equally to Iowa, except that to the total for materials may be added $3,327 for half-feed of horses and mules during the idle time of mines temporarily suspending work during the census year, and that there is nothing to add to "Lumber".	
						1
						2
14	3,500	7,000	28	5,750		3
6	5,300	10,600	40	7,950		4
						5
						6
						7
						8
						9
						10
1	500	1,000	3	750		11
						12
5	485	1,455	9	740		13
1	125	175	3	100		14
30	4,693	6,178	40	4,055		15
						16
						17
5	2,300	4,600	14	3,450		18
						19
						20
						21
1	80	140	1	100		22
						23
						24
5	1,800	3,150	10	2,250		25

KANSAS.

81	7,845	$19,276	241	$9,247	These statistics were obtained from enumerator's schedules entirely.	
6	900	1,800	18	900		1
18	1,897	3,528	50	1,550		2
						3
						4
16	1,600	3,200	32	1,600		5
						6
						7
						8
6	900	2,075	16	900		9
						10
5	575	2,156	25	1,427		11
						12
						13
						14
						15
4	106	598	6	213		16
3	270	1,125	7	430		17
						18
7	340	1,630	18	990		19
1	120	300	3	100		20
4	46	92	42	46		21
						22
1	540	1,275	2	540		23
10	551	1,497	22	551		24

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

KENTUCKY.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
	The State	65	2,435,776	935,857	$1,123,046	946,288	$1,134,960	$1,968,537
1	Bath					63	63	
2	Bell					272	272	
3	Boyd	1	400,000	202,091	252,613	202,516	252,976	231,500
4	Breathitt	1	1,000	500	500	608	608	850
5	Butler	3	19,452	17,488	22,500	17,615	22,627	22,200
6	Caldwell					80	80	
7	Carter	1	125,000	45,126	49,638	46,811	51,800	145,000
8	Clay					154	154	
9	Clinton					102	102	
10	Crittenden	3	23,000	15,000	15,500	15,100	15,600	25,200
11	Daviess	2	20,000	8,370	10,355	8,650	10,635	57,500
12	Edmonson					50	50	
13	Elliott					82	82	
14	Estill					198	198	
15	Floyd					122	122	
16	Grayson					126	126	
17	Greenup	1	100,000	10,000	10,000	10,340	10,340	122,000
18	Hancock	2	37,000	23,680	43,134	23,782	43,236	68,500
19	Harlan					63	63	
20	Henderson	4	110,000	61,123	67,483	61,323	67,683	67,750
21	Hopkins	4	513,200	230,182	230,777	230,357	230,952	483,700
22	Jackson					100	100	
23	Johnson					169	169	
24	Knox					257	257	
25	Laurel					129	129	
26	Lawrence					199	199	
27	Lee	9	369,256	26,973	41,505	27,970	43,240	46,612
28	Letcher					99	99	
29	Madison	2	4,930	1,930	3,700	1,930	3,700	7,700
30	Magoffin					143	143	
31	Martin					56	56	
32	McLean	2	4,226	1,155	1,639	2,063	2,877	3,300
33	Menifee	2	160,000	14,150	24,950	14,254	25,054	13,000
34	Montgomery					226	226	
35	Morgan	1	380	380	696	541	857	6,400
36	Muhlenburgh	6	129,468	78,638	80,030	78,778	80,170	165,350
37	Ohio	5	179,700	78,081	89,425	78,317	89,661	121,470
38	Owsley					71	71	
39	Perry					138	138	
40	Pike					116	116	
41	Powell					83	83	
42	Pulaski	9	63,100	17,450	22,260	17,744	22,554	75,800
43	Rockcastle	4	62,864	39,600	62,400	39,715	62,515	89,110
44	Rowan					73	73	
45	Union	7	107,700	61,398	87,241	61,578	87,421	205,495
46	Wayne					190	190	
47	Webster	2	5,500	2,542	6,700	2,672	6,830	10,100
48	Whitley					184	184	
49	Wolfe					79	79	

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

KENTUCKY.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1,058	122	679	67	2,826	$687,474	28	$2,010	348	$23,897	18	522	23	738	
														1
														2
295	15	48	2	360	94,818			40	3,000	1	50	4	120	3
2		2		4	345			1	50					4
54	4	14		72	18,045			9	575					5
														6
91		10	1	102	33,660			12	1,080					7
														8
														9
26	4	9	2	41	10,095			10	500					10
19	1	19	2	41	5,456			6	300	1	8	1	8	11
														12
														13
														14
														15
														16
60		12		72	8,500			3	300					17
64	14	19	1	98	26,103			24	1,500					18
														19
105	10	38	1	154	53,770	5	300	23	1,480	5	120	3	135	20
370	16	125	21	532	162,722	5	475	89	6,300	2	44	3	110	21
														22
														23
														24
														25
														26
80		20		100	9,286	10	750	2	300					27
														28
15				15	1,800									29
														30
														31
4				4	552									32
31	9	13	18	71	14,963	2	50							33
														34
2				2	192									35
168	7	54	4	233	48,649	3	190	25	2,012	3	95	4	120	36
196	14	40	1	251	60,681	1	45	25	1,020	3	135	3	155	37
														38
														39
														40
														41
99	1	24	6	130	14,632			19	2,225					42
98	12	109	7	226	53,928	2	200	10	825					43
														44
169	14	121	1	305	66,674			44	2,130	3	70	5	90	45
														46
10	1	2		13	2,603			6	300					47
														48
														49

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

KENTUCKY.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22.	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	14	11	$41,018	$54,977	$95,995		875,116	109,000
1	Bath								
2	Bell								
3	Boyd	1		5,500	6,901	12,401		225,000	
4	Breathitt			30	20	50			
5	Butler			1,318	1,875	3,193		20,000	
6	Caldwell								
7	Carter	1		1,600	2,670	4,270		175,000	
8	Clay								
9	Clinton								
10	Crittenden			880	2,095	2,975		21,500	
11	Daviess	1		325	1,035	1,360		40,000	
12	Edmonson								
13	Elliott								
14	Estill								
15	Floyd								
16	Grayson								
17	Greenup			750	1,250	2,000			
18	Hancock			475	3,425	3,900		32,000	
19	Harlan								
20	Henderson	4	2	5,935	3,080	9,015		13,250	5,000
21	Hopkins	1	3	11,700	8,186	19,886		53,000	43,000
22	Jackson								
23	Johnson								
24	Knox								
25	Laurel								
26	Lawrence								
27	Lee			284	1,371	1,655		5,000	
28	Letcher								
29	Madison			49	92	141			
30	Magoffin								
31	Martin								
32	McLean			43	59	102			
33	Menifee			356	781	1,137		10,000	
34	Montgomery								
35	Morgan				10	10		500	
36	Muhlenburgh	3	3	4,230	5,344	9,574		8,500	15,000
37	Ohio	2	1	2,350	4,023	6,373		40,750	46,000
38	Owsley								
39	Perry								
40	Pike								
41	Powell								
42	Pulaski			430	800	1,230		2,500	
43	Rockcastle		2	930	3,129	4,059		17,500	
44	Rowan								
45	Union	1		3,438	8,126	11,564		199,366	
46	Wayne								
47	Webster			395	705	1,100		11,250	
48	Whitley								
49	Wolfe								

TABLE 20.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

KENTUCKY.

FARMERS' DIGGINGS.						
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
73	10,431	$11,914	93	$8,080	*Wages*, when not returned as "net" and when not very low, have been reduced to "net" by deducting as follows: For oil, $1 per miner per month, and for powder (when used and not given), one keg at $3 75 per miner per month.	
1	63	63	1	45	*Materials:* To the total "materials" may be added $4,433 for half-feed of horses and mules during idle time and for feed of 16 oxen during working time. Feed of horses and mules has been estimated at $6 per head per working month, and for oxen at $8 per head per working month.	1
1	272	272	1	204		2
2	425	363	3	319	*Lumber:* In addition to the amount of unsawed lumber given, 130,000 feet (board measure) of "unsawed" lumber were returned.	3
1	108	108	1	81		4
1	127	127	1	95		5
1	80	80	1	60		6
13	1,685	2,172	24	1,527		7
1	154	154	1	115		8
1	102	102	1	77		9
1	100	100	1	75		10
1	280	280	1	210		11
1	50	50	1	37		12
1	82	82	1	62		13
1	198	198	1	148		14
1	122	122	1	92		15
1	126	126	1	94		16
2	340	340	7	265		17
1	102	102	1	77		18
1	63	63	1	45		19
1	200	200	1	150		20
1	175	175	1	131		21
1	100	100	1	75		22
1	169	169	1	127		23
1	257	257	1	193		24
1	129	129	1	97		25
1	199	199	1	149		26
6	997	1,735	6	853		27
1	99	99	1	75		28
						29
1	143	143	1	107		30
1	56	56	1	42		31
5	908	1,238	8	660		32
1	104	104	1	78		33
1	226	226	1	169		34
1	161	161	1	121		35
1	140	140	1	105		36
1	236	236	1	177		37
1	71	71	1	53		38
3	138	128	3	93		39
1	116	116	1	87		40
1	83	83	1	62		41
1	294	294	1	135		42
1	115	115	1	86		43
1	73	73	1	55		44
1	180	180	1	135		45
1	190	190	1	143		46
1	130	130	1	97		47
1	184	184	1	138		48
1	79	79	1	59		49

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

MARYLAND.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Values of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
	The State	32	4,532,822	2,227,844	$2,584,455	2,228,917	$2,585,537	$13,165,557
1	Alleghany	27	4,240,222	2,198,073	2,557,517	2,198,325	2,557,742	12,926,457
2	Garrett	5	292,600	29,771	26,938	30,592	27,795	239,100

MICHIGAN.

	The State	6	141,800	100,800	$224,500	100,800	$224,500	$66,800
1	Jackson	5	126,800	85,800	182,500	85,800	182,500	46,800
2	Shiawassee	1	15,000	15,000	42,000	15,000	42,000	20,000

MISSOURI.

	The State	144	1,120,112	543,990	$1,037,100	844,304	$1,464,425	$389,315
1	Adair	3	4,464	4,464	9,220	4,464	9,220	7,000
2	Audrain	1	2,000	1,174	2,348	1,174	2,348	.....
3	Barton	6	42,915	22,114	25,670	23,501	27,763	9,460
4	Bates	13	53,900	19,385	20,380	308,545	425,215	26,300
5	Boone	1	2,400	400	1,000	400	1,000	25
6	Callaway	2	10,000	800	1,600	951	1,826	.....
7	Carroll	1	1,600	1,600	4,000	2,030	5,060	200
8	Cass	.....	.....	.....	.....	388	582	.....
9	Cedar	.....	.....	.....	.....	140	337	.....
10	Chariton	4	2,300	590	2,360	606	2,410	.....
11	Cole	2	1,700	910	2,800	910	2,800	1,500
12	Cooper	4	11,250	8,000	17,500	8,352	18,204	7,500
13	Dade	1	560	560	1,125	1,685	3,225	600
14	Henry	8	102,258	56,333	102,728	56,904	104,319	18,400
15	Johnson	5	8,400	6,910	18,300	6,910	18,300	9,870
16	La Fayette	16	196,825	75,816	129,215	77,326	132,235	82,250
17	Lincoln	.....	.....	.....	.....	285	626	.....
18	Linn	2	650	325	975	325	975	.....
19	Livingston	3	1,800	1,800	5,650	2,060	6,380	1,350
20	Macon	15	242,400	155,520	302,522	155,520	302,522	15,730
21	Moniteau	.....	.....	.....	.....	990	1,778	.....
22	Monroe	.....	.....	.....	.....	1,175	2,350	.....
23	Montgomery	3	3,550	2,300	4,725	2,300	4,725	3,200
24	Nodaway	3	5,565	2,342	6,630	2,660	7,754	6,500
25	Platte	.....	.....	.....	.....	20	40	.....
26	Putnam	3	16,300	15,100	19,775	15,100	19,775	3,200
27	Ralls	1	500	200	800	200	800	50
28	Randolph	13	266,735	119,745	232,670	120,078	233,362	147,530
29	Ray	10	110,800	29,480	79,225	29,480	79,225	40,675
30	Saline	10	17,940	8,442	18,604	8,727	19,174	1,625
31	Schuyler	.....	.....	.....	.....	30	45	.....
32	Saint Charles	3	5,900	5,900	19,100	5,900	19,100	4,100
33	Saint Clair	2	3,500	1,350	2,708	1,375	2,759	500
34	Sullivan	2	2,200	1,600	3,750	1,600	3,750	650
35	Vernon	2	1,700	830	1,720	2,193	4,441	1,100

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

MARYLAND.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
2,660	475	505	37	3,677	$1,370,079	301	$37,094	31	$3,130	7	860	17	850	
2,536	466	489	35	3,526	1,347,115	290	35,864	24	2,630	7	860	17	850	1
124	9	16	2	151	22,964	11	1,230	7	500	.....	.....	.....	.....	2

MICHIGAN.

295	65	51	1	412	$146,000	.....	.....	.....	.....	6	235	14	.....	
245	53	40	1	339	116,000	.....	.....	.....	.....	5	205	10	.....	1
50	12	11	.....	73	30,000	.....	.....	.....	.....	1	30	4	.....	2

MISSOURI.

2,096	238	253	12	2,599	$642,772	.....	.....	.....	.....	13	518	14	.....	
16	.....	3	.....	19	4,800	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	10	.....	10	1,761	.....	.....	.....	.....	.....	.....	.....	.....	2
87	.....	.....	.....	87	13,500	.....	.....	.....	.....	.....	.....	.....	.....	3
61	.....	21	.....	82	9,728	.....	.....	.....	.....	.....	.....	.....	.....	4
6	.....	.....	.....	6	500	.....	.....	.....	.....	.....	.....	.....	.....	5
8	.....	.....	.....	8	600	.....	.....	.....	.....	.....	.....	.....	.....	6
12	.....	3	.....	15	3,400	.....	.....	.....	.....	.....	.....	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
9	.....	.....	.....	9	725	.....	.....	.....	.....	.....	.....	.....	.....	10
8	2	4	1	15	1,200	.....	.....	.....	.....	.....	.....	.....	.....	11
6	2	16	.....	24	4,000	.....	.....	.....	.....	.....	.....	.....	.....	12
4	.....	.....	.....	4	840	.....	.....	.....	.....	.....	.....	.....	.....	13
66	11	12	1	90	34,453	.....	.....	.....	.....	1	20	1	.....	14
31	8	6	2	47	9,580	.....	.....	.....	.....	.....	.....	.....	.....	15
536	12	36	.....	584	90,107	.....	.....	.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
7	.....	3	.....	10	345	.....	.....	.....	.....	.....	.....	.....	.....	18
8	.....	4	.....	12	2,700	.....	.....	.....	.....	.....	.....	.....	.....	19
563	93	59	3	718	204,395	.....	.....	.....	.....	7	320	8	.....	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22
24	.....	.....	.....	24	2,792	.....	.....	.....	.....	.....	.....	.....	.....	23
32	.....	.....	.....	32	4,322	.....	.....	.....	.....	.....	.....	.....	.....	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25
44	.....	3	.....	47	12,000	.....	.....	.....	.....	.....	.....	.....	.....	26
3	1	.....	.....	4	150	.....	.....	.....	.....	.....	.....	.....	.....	27
345	47	44	4	440	153,402	.....	.....	.....	.....	5	169	5	.....	28
155	57	18	.....	230	64,075	.....	.....	.....	.....	.....	9	.....	.....	29
17	.....	3	1	21	5,854	.....	.....	.....	.....	.....	.....	.....	.....	30
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31
28	5	3	.....	36	13,800	.....	.....	.....	.....	.....	.....	.....	.....	32
8	.....	5	.....	13	1,450	.....	.....	.....	.....	.....	.....	.....	.....	33
4	.....	.....	.....	4	800	.....	.....	.....	.....	.....	.....	.....	.....	34
8	.....	.....	.....	8	1,493	.....	.....	.....	.....	.....	.....	.....	.....	35

TABLE 20.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

MARYLAND.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	17	5	$40	$194,902	$194,942		1,379,444	
1	Alleghany	14	5		189,103	189,103		1,379,444	
2	Garrett	3		40	5,799	5,839			

MICHIGAN.

	The State	6	7	$4,700	$3,050	$7,750	375		
1	Jackson	5	5	700	3,050	3,750	375		
2	Shiawassee	1	2	4,000		4,000			

MISSOURI.

	The State	45	17	$3,282	$52,474	$55,756	9,511		
1	Adair	2		15	610	625	8		
2	Audrain								
3	Barton								
4	Bates	2	2	405	976	1,381	9		
5	Boone				45	45	10		
6	Callaway				35	35			
7	Carroll	1	1						
8	Cass								
9	Cedar								
10	Chariton				211	211	85		
11	Cole	2	1	50	225	275			
12	Cooper	1	4	350	500	850			
13	Dade								
14	Henry	5	3		776	776	27		
15	Johnson				500	500	10		
16	La Fayette	3	1		3,530	3,530			
17	Lincoln								
18	Linn				48	48	4		
19	Livingston	1			295	295	10		
20	Macon	7	1	19	30,045	30,064	8,810		
21	Moniteau								
22	Monroe								
23	Montgomery	2	2	20	350	370	185		
24	Nodaway				279	279			
25	Platte								
26	Putnam	1			600	600			
27	Ralls				30	30	10		
28	Randolph	10	2	2,033	10,815	12,848	285		
29	Ray	8			1,650	1,650	35		
30	Saline				100	100			
31	Schuyler								
32	Saint Charles			300	650	950	23		
33	Saint Clair			85		85			
34	Sullivan				7	7			
35	Vernon			5	197	202			

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

MARYLAND.

FARMERS' DIGGINGS.					Remarks.	
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.		
30	31	32	33	34		
	Tons.					
15	1,073	$1,082	17	$532	*Wages* have been reduced to "net" by deducting 40 cents per miner per working month for blacksmithing and 80 cents per underground employé per working month for lighting-oil.	
2	252	225	2	115	*Materials:* Feed, when not included in original returns, has been estimated at $9 per head per month. Oil and blacksmithing as deducted from wages were added to materials in every case. In one concern feed was taken	1
13	821	857	15	417	at $18 per head per month, according to its instructions. To total materials for the state may be added for half-feed for idle time of horses and mules in mines temporarily suspending operations during census year, $4,939.	2
					Lumber (unsawed): When used but not returned has been estimated at 2 cents per ton of coal mined, and valued at 5 cents per linear foot. To the total lumber should be added 15,000 ties and 28,000 props, but the value of these is already included in the column of value of lumber.	
					Hoisting machinery includes inclined planes, drums, etc., for lowering coal.	

MICHIGAN.

					These statistics were taken from enumerators' returns entirely.	
						1
						2

MISSOURI.

90	300,314	$427,325	3,125	$155,149	These statistics were collected entirely by enumerators. Whenever the product amounted to less than $500 the data, were transferred to farmers' diggings blanks.	
					Tons supposed to be of 2,000 pounds.	
					Returns which were evidently erroneous have been replaced by estimates. Many of them were grossly erroneous. *In a number of cases* the production was not returned, nor wages, nor employés, and yet there was	1
					no indication that the mine was idle. In such cases these items have all been estimated, taking as the basis	2
10	1,387	2,093	17	734	the average production of mines in Missouri producing less than 1,000 tons.	3
	289,160	404,835	2,887	144,580	*Acres:* In some counties there are no returns of acreage.	4
					Capital: In some counties there are no returns of capital. It has not seemed advisable to attempt to supply these omissions by estimates.	5
1	151	226	3	75		6
2	430	1,060	7	323		7
1	388	582	7	194		8
2	140	337	6	115		9
1	16	50	3	20		10
						11
2	352	704	6	450		12
8	1,125	2,100	33	964		13
9	571	1,501	19	571		14
						15
7	1,510	3,020	14	1,510		16
2	285	626	5	285		17
						18
2	260	730	4	260		19
						20
4	990	1,778	9	1,106		21
5	1,175	2,350	10	1,175		22
						23
6	318	1,124	23	527		24
1	20	40	1	20		25
						26
						27
4	333	692	11	334		28
						29
6	285	570	14	285		30
1	30	45	3	30		31
						32
2	25	51	2	25		33
						34
14	1,363	2,721	41	1,566		35

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

NEBRASKA.

	Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
	The State	1	400	200	$750	200	$750	$500
1	Pawnee	1	400	200	750	200	750	500

NORTH CAROLINA.

	The State	1	700	350	$400	350	$400	$40,170
1	Chatham	1	700	350	400	350	400	40,170

OHIO.

	The State	618	12,093,880	5,932,853	$7,629,488	6,008,595	$7,719,667	$13,652,484
1	Athens	16	778,600	310,750	320,543	323,050	334,668	819,835
2	Belmont	49	797,790	399,747	399,263	399,747	399,263	494,082
3	Carroll	14	104,380	11,477	15,063	12,557	16,413	69,966
4	Columbiana	53	867,835	515,602	584,095	524,712	596,643	613,955
5	Coshocton	20	177,006	82,216	96,617	85,531	101,561	115,640
6	Gallia	7	56,608	13,379	15,174	21,032	22,671	27,035
7	Guernsey	9	216,300	157,650	171,800	157,650	171,800	186,800
8	Harrison	9	20,400	20,400	25,945	20,400	25,945	15,310
9	Hocking	7	593,100	331,170	338,689	332,822	340,514	514,300
10	Holmes	7	56,240	12,963	18,450	19,060	25,696	71,200
11	Jackson	38	712,446	229,068	290,781	233,024	294,737	569,770
12	Jefferson	16	597,194	324,070	282,681	324,070	282,681	485,380
13	Lawrence	30	161,365	125,579	157,035	125,579	157,035	301,565
14	Mahoning	12	333,100	235,305	488,727	235,305	488,727	476,058
15	Medina	2	106,000	106,000	170,000	106,000	170,000	234,000
16	Meigs	29	527,400	359,225	428,723	359,225	428,723	776,421
17	Monroe	6	3,370	3,310	3,819	3,310	3,819	3,450
18	Morgan	5	235,450	3,680	4,313	11,231	13,714	10,100
19	Muskingum	48	452,750	135,737	142,562	140,279	148,015	226,296
20	Noble	21	94,937	24,760	27,060	24,760	27,060	27,850
21	Perry	24	2,006,481	913,974	913,392	913,974	913,392	4,286,520
22	Portage	3	100,600	27,780	60,625	27,780	60,625	46,000
23	Scioto	4	5,800	3,365	7,210	6,048	9,222	5,415
24	Stark	69	1,174,930	347,820	512,103	357,610	525,780	1,107,523
25	Summit	9	198,400	115,464	201,893	115,824	202,343	330,500
26	Trumbull	25	844,159	722,265	1,442,628	722,265	1,442,628	967,323
27	Tuscarawas	51	550,780	255,495	311,361	255,495	311,361	451,760
28	Vinton	5	159,300	57,200	78,176	62,108	82,474	197,600
29	Washington	11	31,449	31,449	33,511	31,449	33,511	20,750
30	Wayne	19	129,710	55,953	87,249	56,698	88,646	200,080

TABLE 29.—*Production of bituminous coal east of the* 100*th meridian, by states and counties*—Continued.

NEBRASKA.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
5	.....	.....	.....	5	$200	.....	.....	.....	.....	.....	.....	.....	.....	
5	.....	.....	.....	5	200	.....	.....	.....	.....	.....	.....	.....	.....	1

NORTH CAROLINA.

2	.....	1	1	4	$300	1	$50	.....	.....	.....	.....	.....	.....	
2	.....	1	1	4	300	1	50	.....	.....	.....	.....	.....	.....	1

OHIO.

13,626	755	1,852	98	16,331	$5,100,587	319	$27,090	1,228	$91,165	131	3,835	227	5,296	
775	62	102	13	952	279,457	40	4,005	61	5,520	6	146	5	143	1
604	13	103	3	723	257,884	12	1,000	55	4,310	6	130	7	165	2
61	.....	10	.....	71	18,356	.....	.....	4	385	.....	.....	.....	.....	3
1,080	70	118	12	1,280	444,492	.....	.....	116	8,320	10	139	11	175	4
234	4	27	.....	265	67,615	2	180	31	2,260	.....	.....	.....	.....	5
37	.....	6	.....	43	8,938	.....	.....	4	325	.....	.....	.....	.....	6
288	3	34	12	337	114,142	4	330	41	2,370	1	18	3	55	7
63	.....	10	.....	73	16,156	.....	.....	.....	.....	.....	.....	.....	.....	8
526	12	112	2	652	266,081	52	4,625	35	2,875	2	30	2	30	9
33	.....	3	.....	36	10,143	1	50	2	200	.....	.....	.....	.....	10
635	29	77	2	743	205,056	2	125	58	4,095	9	239	10	269	11
496	43	136	1	676	195,205	19	1,150	75	5,395	8	381	14	620	12
290	42	51	3	386	113,145	2	150	38	3,235	1	50	1	35	13
730	35	76	4	845	309,592	3	230	62	4,670	13	414	24	605	14
282	10	20	.....	312	74,580	.....	.....	26	2,200	2	64	3	64	15
828	54	156	13	1,051	166,365	29	1,925	162	9,900	4	140	9	200	16
21	.....	1	.....	22	2,482	.....	.....	.....	.....	1	13	1	25	17
17	.....	.....	.....	17	2,283	.....	.....	.....	.....	1	17	2	29	18
342	5	38	2	387	100,689	2	100	11	1,000	.....	.....	.....	.....	19
75	5	4	.....	84	15,785	.....	.....	2	200	.....	.....	.....	.....	20
1,505	64	189	5	1,763	708,869	82	7,130	71	6,935	7	176	14	310	21
120	2	14	.....	136	33,360	.....	.....	5	500	2	60	3	75	22
18	.....	1	.....	19	5,809	.....	.....	.....	.....	.....	.....	.....	.....	23
1,381	73	182	1	1,637	347,023	43	4,000	92	6,005	15	449	37	701	24
355	11	49	2	417	114,555	1	100	19	1,700	7	179	11	192	25
1,819	146	195	15	2,175	880,688	10	920	171	12,085	26	1,013	62	1,408	26
601	32	82	2	717	198,999	3	270	50	3,805	4	45	4	65	27
146	17	35	4	202	65,227	12	800	12	700	.....	.....	.....	.....	28
63	3	2	.....	68	20,069	.....	.....	.....	.....	1	20	1	25	29
201	20	19	2	242	57,542	.....	.....	25	2,175	5	112	3	105	30

TABLE 29.—*Production of bituminous coal east of the* 100*th meridian, by states and counties*—Continued.

NEBRASKA.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet. B. M.*
	The State			$5	$5	$10			
1	Pawnee			5	5	10			

NORTH CAROLINA.

	The State	1			$50	$50			
1	Chatham	1			50	50			

OHIO.

	The State	120	131	$210,453	$720,845	$931,298	2,397	4,135,378	378,697
1	Athens	3	3	10,637	26,973	37,610	10	180,000	
2	Belmont	6	6	10,683	29,858	40,541	72	240,049	
3	Carroll			1,491	3,938	5,429	59	20,001	
4	Columbiana	8	6	12,419	47,022	59,441	150	633,832	
5	Coshocton			924	9,110	10,034	15	151,070	
6	Gallia			551	866	1,417			
7	Guernsey	1	3	6,179	17,156	23,335		234,000	
8	Harrison		2	726	72	798	53		
9	Hocking	1		9,087	33,550	42,637		126,250	20,000
10	Holmes	1		594	1,222	1,816	53		
11	Jackson	9	13	13,381	16,946	30,327	317	1,600	
12	Jefferson	7	9	10,612	21,453	32,065		176,550	
13	Lawrence	1	1	3,638	11,450	15,088	110	60,491	129,037
14	Mahoning	11	13	5,062	26,231	31,293		252,901	27,000
15	Medina	2	2	5,650	9,760	15,410	250	40,000	
16	Meigs	4	2	13,796	161,533	175,329		4,771	
17	Monroe	1	1	118	256	374			
18	Morgan	1	1	131	57	188			
19	Muskingum			2,784	8,127	10,911		43,760	
20	Noble	7		935	1,718	2,653	12	3,600	
21	Perry	5	8	31,184	74,020	105,204	113	334,030	
21	Portage	2	2	172	4,947	5,119		64,500	
22	Scioto			113	945	1,058	8		
24	Stark	17	22	27,518	47,501	75,019	371	386,667	
25	Summit	9	9	5,911	21,091	27,002	580	90,000	
26	Trumbull	18	25	23,251	102,329	125,580		914,397	202,660
27	Tuscarawas	3	1	6,453	29,917	36,370	36	176,910	
28	Vinton			951	7,902	8,853			
29	Washington	1	1	1,120	1,494	2,614	50		
30	Wayne	2	1	4,382	3,401	7,783	138		

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

NEBRASKA.

FARMERS' DIGGINGS.						
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
.....	.....	.....	.....	.....	These statistics were collected by enumerators.	
.....	.....	.....	.....	.....	.....	1

NORTH CAROLINA.

.....	.....	.....	.....	.....		
.....	.....	.....	.....	.....	.....	1

OHIO.

691	75,742	$90,179	252	$56,840	*Capital in real estate:* Whenever it has not been possible to obtain a return of this, the result has been reached by multiplying the number of acres unworked by the estimated mineral value of land per acre. The following scale has been used: Columbiana county, near railroad, $100; off railroad, $60; Belmont county,	
40	12,300	14,125	41	9,225	$75; Jackson county, $50; Hocking county, $100; Mahoning county, $200; Muskingum county, $75; Portage	1
.....	.....	.....	.....	.....	county, $200; Perry county, $100; Scioto county, $55; Stark county (Massillon district, western third of	2
10	1,080	1,350	3	810	county), $140; balance, $100; Trumbull county, $200; Tuscarawas county, $45; Vinton county, $40.	3
67	9,110	12,548	31	6,832	*Wages and materials:* In the returns these were generally confounded. In order to correct them a circular was issued, and the following rules were framed and applied after obtaining totals and averages from 24	4
35	3,315	4,944	11	2,486	mines. The totals were: Product, 689,218 tons; gross wages, $539,337; materials for miners, $40,136; net wages $499,213; operators' materials, $36,244; total materials, $76,680. When gross wages are given and	5
129	7,653	7,497	26	5,740	powder used, deduct 7.4 per cent. from wages; when gross wages are given but no powder used, deduct 3 per cent. from wages. When materials are not given, estimate them at 11 cents per ton, + $5 per horse or mule per working month, + $2.50 per head per idle month. When not given and powder not used, estimate at	6
.....	.....	.....	.....	.....	$4\frac{1}{2}$ cents per ton, + 3 per cent. of gross wages, + as above for horses and mules. When operators' materials are alone given and powder used, estimate by adding $5\frac{8}{10}$ cents per ton, + as above for horses and mules. When	7
.....	.....	.....	.....	.....	operators' materials are alone given but no powder used, estimate by adding 3 per cent. of gross wages, + as abovefor horses and mules.	8
15	1,652	1,825	5	1,239	*Powder:* Estimated as follows: By miners, $3\frac{4}{10}$ cents per ton, divided by 15, to arrive at pounds; by operators,	9
35	6,097	7,246	21	4,608	$\frac{4}{10}$ cent per ton, divided by $12\frac{1}{2}$, to arrive at pounds.	10
63	3,956	3,956	12	2,967	*Lumber:* Basis for estimates: Length of prop and cap = thickness of seam; ties, 5 feet long; props and caps, $1\frac{1}{2}$ cents per ton of coal mined; tracking, $1\frac{1}{4}$ cents for ditto; total, $2\frac{3}{4}$ cents; value of cord-wood, $2.75 per cord.	11
.....	.....	.....	.....	.....	*Farmers' diggings:* In these and all the smallest mines when wages have not been given, they have been estimated at 75 cents a ton. The average amount produced by one man during the census year in such mines	12
.....	.....	.....	.....	.....	has been estimated at 300 tons. Since the footings were made the following enumerators' returns have been received: Capital, $800; 1 acre of coal land; 1 man employed under ground; wages, $325; materials, $25;	13
.....	.....	.....	.....	.....	product, 710 tons; value, $710. Capital, $1,500; 8 acres of coal land; 6 men employed under ground, 4 men	14
.....	.....	.....	.....	.....	above ground, 1 boy under ground; wages, $800; materials, $200 product, 1,320 tons; value, $1,500.	15
.....	.....	.....	.....	.....	.....	16
.....	.....	.....	.....	.....	.....	17
125	7,551	9,401	25	5,663	.....	18
37	4,542	5,453	15	3,406	.....	19
.....	.....	.....	.....	.....	.....	20
.....	.....	.....	.....	.....	.....	21
.....	.....	.....	.....	.....	.....	22
19	2,683	2,012	9	2,012	.....	23
51	9,790	13,677	34	7,342	.....	24
2	360	450	1	270	.....	25
.....	.....	.....	.....	.....	.....	26
.....	.....	.....	.....	.....	.....	27
54	4,908	4,298	16	3,681	.....	28
.....	.....	.....	.....	.....	.....	29
9	745	1,397	2	559	.....	30

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

PENNSYLVANIA.

	Counties.	Number of establishments.	Maximum yearly capacity production.	Product of establishments, census year.	Values of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
	The State	666	26,229,031	18,004,988	$18,157,151	18,425,163	$18,567,129	$33,709,344
1	Allegheny	105	6,722,832	4,426,871	4,732,670	4,467,227	4,775,126	9,786,757
2	Armstrong	22	130,021	74,859	70,147	116,423	109,699	169,560
3	Beaver	40	169,216	126,717	171,321	143,622	190,837	293,640
4	Bedford	3	130,000	92,166	82,130	92,166	82,130	99,833
5	Blair	8	367,065	293,834	278,377	294,384	278,997	399,682
6	Bradford	2	614,748	500,965	862,773	500,965	862,773	653,148
7	Butler	49	190,945	156,417	169,162	197,675	213,535	221,810
8	Cameron	1	43,000	43,000	51,000	43,000	51,000	132,000
9	Cambria	26	840,570	590,075	561,256	590,075	561,256	1,749,188
10	Centre	2	294,800	131,571	95,417	131,571	95,417	382,422
11	Clarion	33	487,062	286,846	286,713	317,297	322,560	791,290
12	Clearfield	29	2,865,800	1,722,711	1,470,747	1,722,711	1,470,747	3,133,175
13	Clinton	3	52,200	2,828	2,878	2,828	2,878	512,000
14	Elk	5	595,000	281,151	312,875	285,453	317,934	1,328,365
15	Fayette	63	2,700,912	2,318,728	1,318,912	2,356,983	1,349,657	3,868,070
16	Greene	4	8,652	6,781	6,754	30,153	26,611	2,650
17	Huntingdon	6	356,000	207,205	188,250	207,205	188,250	818,357
18	Indiana	21	154,945	46,445	34,762	58,881	45,650	135,400
19	Jefferson	13	327,276	180,515	144,981	199,074	164,298	178,614
20	Lawrence	24	285,234	165,528	209,807	183,273	231,075	418,459
21	Lycoming	1	275,000	200,923	287,432	200,923	287,432	250,000
22	McKean	2	160,000	147,378	173,294	147,378	173,294	680,571
23	Mercer	44	678,205	485,276	856,252	488,913	860,947	813,682
24	Somerset	23	749,688	286,456	234,402	302,293	249,552	1,163,690
25	Tioga	6	1,252,000	938,517	1,502,815	938,517	1,502,815	2,053,615
26	Venango	8	51,190	25,793	35,674	41,808	52,683	92,485
27	Warren					278	500	
28	Washington	50	1,384,485	968,042	950,180	1,006,529	985,155	1,506,420
29	Westmoreland	73	4,342,185	3,297,390	3,066,170	3,357,558	3,114,321	7,074,461

TENNESSEE.

	The State	20	746,050	494,491	$628,954	495,131	$629,724	$1,708,968
1	Anderson	6	277,500	140,818	146,376	140,818	146,376	182,700
2	Campbell	1	9,300	1,200	2,100	1,460	2,490	5,038
3	Cumberland	1	400	24	60	24	60	150
4	Franklin	3	1,450	1,325	3,330	1,705	3,710	8,172
5	Grundy	1	240,000	200,000	250,000	200,000	250,000	1,025,000
6	Hamilton	1	100,000	50,000	67,500	50,000	67,500	189,000
7	Marion	5	51,400	43,124	110,088	43,124	110,088	183,908
8	Roane	1	60,000	56,000	42,000	56,000	42,000	113,000
9	White	1	6,000	2,000	7,500	2,000	7,500	2,000

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

PENNSYLVANIA.

EMPLOYÉS.										STEAM-POWER.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
26,550	1,941	4,489	268	33,248	$10,863,583	484	$55,040	3,019	$345,625	170	5,391	321	9,048	
7,854	381	1,227	42	9,504	3,118,325	188	23,785	721	92,615	37	1,127	47	1,801	1
163	9	18	.....	190	46,546	2	200	28	3,175	.....	.....	.....	.....	2
316	20	45	3	384	114,680	22	2,740	30	2,420	1	10	1	6	3
129	6	31	.....	166	42,102	.....	.....	22	2,900	1	40	1	50	4
419	66	49	33	567	172,740	3	350	56	6,425	6	260	13	280	5
452	75	87	1	615	297,719	1	150	105	10,506	1	30	3	80	6
306	22	48	2	378	107,062	16	2,000	28	3,525	7	90	8	132	7
45	15	35	5	100	33,500	3	375	10	1,250	.....	.....	.....	.....	8
924	126	94	12	1,156	280,949	2	200	126	13,350	2	45	5	105	9
138	29	23	2	192	58,372	4	500	20	2,750	.....	.....	.....	.....	10
511	41	96	4	652	246,647	12	1,330	69	9,200	1	20	1	20	11
2,478	291	245	15	3,029	797,845	11	1,475	267	30,255	1	25	1	50	12
18	.....	.....	.....	18	2,055	.....	.....	.....	.....	.....	.....	.....	.....	13
482	43	79	13	617	180,481	9	905	33	3,525	2	170	5	55	14
1,945	33	277	12	2,267	802,114	32	2,600	337	34,125	30	1,046	82	2,173	15
12	1	.....	.....	13	4,339	.....	.....	.....	.....	.....	.....	.....	.....	16
378	26	39	.....	443	143,790	3	375	52	5,000	1	40	3	90	17
83	.....	17	.....	100	18,188	.....	.....	4	375	.....	.....	.....	.....	18
253	25	23	12	313	83,516	.....	.....	23	2,775	.....	.....	.....	.....	19
419	38	65	5	527	130,171	26	2,340	48	4,040	3	56	4	80	20
360	.....	240	.....	600	184,000	12	1,800	58	5,800	3	55	3	45	21
201	40	56	3	300	125,578	2	200	37	3,525	2	30	4	140	22
1,048	122	168	9	1,347	453,116	12	1,025	102	9,610	15	493	36	900	23
420	31	55	7	513	139,093	24	2,565	11	1,565	1	30	1	30	24
1,547	159	638	28	2,372	740,880	27	2,800	229	21,240	4	150	8	150	25
66	7	13	3	89	20,942	.....	.....	13	1,250	.....	.....	.....	.....	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	27
1,916	153	208	21	2,298	712,602	18	1,970	172	21,670	11	495	13	280	28
3,667	182	613	36	4,498	1,806,231	55	5,355	418	52,760	41	1,179	82	2,572	29

TENNESSEE.

693	62	242	95	1,092	$336,765	2	$200	139	$14,925	6	132	6	152	
223	19	63	5	310	70,229	2	200	30	2,605	1	12	1	12	1
8	.....	2	1	11	4,289	.....	.....	2	175	.....	.....	.....	.....	2
.....	.....	2	.....	2	45	.....	.....	.....	.....	.....	.....	.....	.....	4
17	1	10	.....	28	2,997	.....	.....	.....	.....	.....	.....	.....	.....	5
225	.....	75	6	306	106,000	.....	.....	49	7,000	2	50	1	50	3
65	15	16	2	98	47,000	.....	.....	13	900	.....	.....	.....	.....	6
73	22	58	80	233	68,905	.....	.....	26	1,870	3	70	4	90	7
81	4	15	1	101	36,000	.....	.....	19	2,375	.....	.....	.....	.....	8
1	1	1	.....	3	1,300	.....	.....	.....	.....	.....	.....	.....	.....	9

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

PENNSYLVANIA.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	96	179	$193,506	$1,561,096	$1,754,602	557	32,246,463	6,574,651
1	Allegheny	8	19	34,160	444,440	478,600	.....	10,303,080	1,382,753
2	Armstrong	.....	2	1,770	6,708	8,478	10	227,641	.....
3	Beaver	1	3	3,633	14,419	18,052	.....	121,644	120,000
4	Bedford	1	1	351	9,200	9,551	.....	71,100	.....
5	Blair	3	2	829	22,425	23,254	375	124,986	51,000
6	Bradford	1	2	9,325	33,248	42,573	50	570,000	.....
7	Butler	7	8	1,906	12,685	14,591	.....	296,414	55,000
8	Cameron	.....	.....	30	4,470	4,500	.....	200,000	100,000
9	Cambria	.....	1	9,745	42,964	52,709	60	1,193,806	40,000
10	Centre	.....	.....	105	11,168	11,273	.....	531,394	.....
11	Clarion	3	3	6,265	22,182	28,447	.....	761,057	53,400
12	Clearfield	1	1	9,571	102,525	112,096	25	1,894,074	.....
13	Clinton	.....	.....	12	100	112	.....	.....	.....
14	Elk	2	.....	2,765	31,616	34,381	.....	796,375	94,000
15	Fayette	24	61	51,804	146,013	197,817	.....	3,238,806	109,400
16	Greene	.....	.....	61	289	350	.....	1,500	.....
17	Huntingdon	1	1	2,793	18,257	21,050	.....	247,887	.....
18	Indiana	.....	.....	920	2,112	3,032	29	15,000	.....
19	Jefferson	3	.....	4,030	10,988	15,018	.....	42,000	68,000
20	Lawrence	4	.....	2,418	23,473	25,891	5	382,793	61,000
21	Lycoming	2	.....	4,550	21,450	26,000	3	420,000	.....
22	McKean	.....	3	650	13,783	14,433	.....	50,000	375,000
23	Mercer	20	27	10,281	64,793	75,074	.....	1,181,463	268,250
24	Somerset	1	.....	348	18,051	18,399	.....	335,151	101,237
25	Tioga	1	1	12,828	148,974	161,802	.....	3,998,070	1,876,000
26	Venango	.....	.....	305	5,231	5,536	.....	274,685	1,584
27	Warren	.....	.....	.....	.....	.....	.....	.....	.....
28	Washington	3	9	8,386	79,006	87,392	.....	1,204,445	431,900
29	Westmoreland	10	35	13,665	250,526	264,191	.....	3,763,692	1,386,127

TENNESSEE.

	The State	.....	8	$11,062	$36,261	$47,323	.....	412,200	796,000
1	Anderson	.....	3	77	10,674	10,751	.....	171,000	.....
2	Campbell	.....	.....	.....	150	150	.....	.....	.....
3	Cumberland	.....	.....	2	3	5	.....	.....	.....
4	Franklin	.....	.....	20	255	275	.....	.....	.....
5	Grundy	.....	5	5,400	15,050	20,450	.....	180,000	370,000
6	Hamilton	.....	.....	1,575	1,625	3,200	.....	.....	.....
7	Marion	.....	.....	868	5,982	6,850	.....	25,200	426,000
8	Roane	.....	.....	3,120	2,512	5,632	.....	36,000	.....
9	White	.....	.....	.....	10	10	.....	.....	.....

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

PENNSYLVANIA.

FARMERS' DIGGINGS.						
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
3,166	420,175	$409,978	3,932	$259,795	*Acres* were not returned in many cases. The total acreage returned, 136,243, represents only 456 mines. Of these 17,731 acres were "worked", 60,775 "unworked", and 57,747 were unspecified. Assuming that those "worked" were worked out and that the proportion of acres worked to those unworked in the returns, *i. e.*,	
303	40,356	42,456	358	27,740	.226 : .774 would hold good for the acres unspecified, we would have: 60,775 acres unworked + .774 of acres	1
352	41,564	39,552	428	28,624	unspecified (44,696) = total 105,471. This divided by 456 would give 231.3 acres unworked per mine. The	2
129	16,905	19,516	186	14,603	total number of mines, leaving out the farmers' diggings, which did not return acreage, is 210. Estimating the acreage of these at the same rate would give 48,573, which, added to the total acreage above, would give	3
					154,044 as the total acreage (unworked) of mines which were producing during the census year.	4
2	550	620	9	350	*Product* includes nut and salable slack. Wherever these had apparently not been included in the return, 20 per cent. was added to the product, excepting in the case of mines connected with coke-, iron-, or glass-works,	5
					or potteries, and in all cases deducting the amount consumed for fuel at the mines; and this amount (20 per cent.) was valued at 33⅓ cents per ton.	
246	41,258	44,373	318	27,550	*Wages:* The expenditure of employés for mine supplies has been deducted from their gross earnings as per scale given below under "Materials".	6
					Capital, real estate: When no answer was returned and when acreage was not given, this has been roughly estimated at a little more than six times the prevailing royalty on a full year's production of the mine in question.	7
					Materials: Feed, when not expressly included in the original returns, has been added throughout at $7 per head per working month. To the total materials for the state may be added for half feed of horses and mules during idle time, in the case of mines producing, but temporarily suspending operations during the census year,	8 9 10
					$29,593, making total materials for the state $1,784,195. Where miners' oil, powder, and tools had evidently not been included in the original returns, they were added according to the following rule, framed from information obtained from Special Agent T. B. Alsop, of Pittsburgh, Pennsylvania, and from the state mine	
347	30,451	35,847	414	20,007	inspector of the 1st, 2d, and 3d mining districts: Miners' oil for the 1st and 2d districts, *i. e.*, for the counties of Bedford, Fayette, Greene, Somerset, Washington, Westmoreland, Allegheny, Armstrong, Beaver, Butler,	11 12 13
35	4,302	5,059	49	2,774	Clarion, Crawford, Erie, Forest, Indiana, Jefferson, Lawrence, Mercer, Warren, and Venango, at $1 per underground employé per working month. For the 3d district, *i. e.*, for the counties of Blair, Bradford, Cambria,	14
367	38,255	30,745	416	19,212	Cameron, Centre, Clearfield, Clinton, Elk, Huntingdon, Lycoming, McKean, and Tioga, at $2 per underground employé per working month. Tools throughout the state at 50 cents per *miner* per working month. Sharpening and repairing of tools in the first two districts at 80 cents per miner per working month, and nothing	15
190	23,372	19,857	244	13,317	in the 3d district, as that is furnished by operators. Powder, when not given, and when used, estimated at 2½ cents per ton in the first six counties named above, in Allegheny county at $2\frac{9}{10}$ cents, and in the remaining	16
69	12,436	10,888	102	5,322	counties of the 2d district, $3\frac{1}{10}$ cents; in the 3d district at ½ cent per ton. Powder, when not given, and when used, has been estimated per above under "Materials".	17
158	18,559	19,317	179	12,341	*Farmers' diggings* include only openings producing less than $500 in value. The statistics of this class of mines were not obtained in the counties of Blair, Bradford, Cambria, Cameron, Centre, Clearfield, Clinton, Elk,	18 19
108	17,745	21,268	150	13,266	Huntingdon, Lycoming, McKean, and Tioga, but are very complete in all the remaining counties.	
					The semi-anthracite of Sullivan county has been tabulated by itself.	20
					Semi-bituminous has not been separated from the bituminous in the totals.	
					No returns have been received from the following concerns, which, according to the state mine inspector's report for 1880, produced the amounts set opposite their names. It is quite possible that several of them	21
					were not in operation during the census year. "Glenwood" mine, Coulter, Huff & Co., Clearfield county, 49,567 tons (in 1879, 19,500); "Jackson" mine, W. J. Jackson; "Clearfield" mine, Clearfield Coal Company,	22
19	3,637	4,695	34	2,848	J. E. Leskie; "Logan" mine, H. J. Smith & Co.; "Shamokin" mine, George Robertson, all in Clearfield	23
163	15,837	15,150	202	7,317	county. The following mines were in operation during the census year, but failed to file schedules: "Argyle No. 1," Argyle Coal Company, Cambria county; "Cameron," Cameron Coal Company, Cameron county;	24
					"Hazel Dell," Rand & Hall, Elk county.	25
120	16,015	17,009	157	11,457		26
1	278	500	2	334		27
213	38,487	34,975	270	21,742		28
344	60,168	48,151	423	30,991		29

TENNESSEE.

3	640	$770	7	$575	The same general principles in regard to capital, wages, and materials were followed in Tennessee as in Ohio and Indiana.	
					Materials: Feed has been estimated at $6 per working month for each mule or horse. To the total "Materials" may be added for half feed of mules and horses during idle time, $344.	1
1	260	390	2	195		2
						3
2	380	380	5	380		4
						5
						6
						7
						8
						9

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

VIRGINIA.

	Counties	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments, census year.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.
		1	2	3	4	5	6	7
			Tons.	*Tons.*		*Tons.*		
	The State	4	105,740	40,520	$92,837	43,079	$99,802	$329,000
1	Botetourt					62	300	
2	Chesterfield	4	105,740	40,520	92,837	40,520	92,837	329,000
3	Montgomery					2,497	6,665	

WEST VIRGINIA.

	The State	129	4,116,485	1,782,569	$1,971,847	1,829,844	$2,013,671	$5,750,674
1	Barbour	1	1,400	950	750	3,361	2,795	7,000
2	Boone	1	33,600	22,400	30,000	22,400	30,000	93,000
3	Braxton					1,312	1,131	
4	Brooke	10	54,340	36,499	44,420	36,499	44,420	50,000
5	Doddridge	1	1,140	760	1,000	1,714	2,290	5,000
6	Fayette	13	916,410	343,677	296,491	343,701	296,515	727,980
7	Gilmer					1,082	895	
8	Grant	2	1,225	770	1,100	1,361	1,874	4,500
9	Hancock	7	25,460	19,950	21,750	19,950	21,750	11,500
10	Harrison	9	525,500	132,201	85,676	143,589	94,791	311,475
11	Kanawha	15	831,540	368,901	581,110	369,209	581,389	2,317,700
12	Lewis	3	2,275	1,680	1,920	4,991	5,460	16,500
13	Marion	16	221,865	103,874	83,518	107,636	86,008	192,900
14	Marshall	6	120,500	67,103	69,162	67,103	69,162	106,825
15	Mason	4	136,000	90,748	148,964	90,748	148,964	374,500
16	Mineral	3	114,800	62,731	70,080	63,171	70,511	27,250
17	Monongahela	7	16,275	12,559	10,425	20,796	17,047	61,500
18	Ohio	14	362,400	205,039	241,313	205,039	241,313	312,500
19	Pleasant	1	5,700	3,800	6,000	3,800	6,000	2,500
20	Preston	4	223,200	136,559	111,645	142,327	117,744	242,500
21	Putnam	1	200,000	49,000	67,375	49,000	67,375	663,000
22	Randolph	2	1,750	1,330	1,820	1,756	2,411	8,500
23	Ritchie	1	3,500	2,625	3,000	3,184	3,642	12,000
24	Roane					798	1,140	
25	Taylor	4	293,475	102,959	76,608	105,962	78,790	165,544
26	Upshur					1,892	1,349	
27	Wetzel	2	1,330	760	1,200	760	1,200	1,500
28	Wood	2	22,800	15,694	16,520	16,723	17,696	35,000

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

VIRGINIA.

Employés.										Steam-power.				
Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boil.	
8	9	10	11	12	13	14	15	16	17	18	19	20	21	
112	1	124	24	261	$71,447	7	$650	31	$3,250	15	763	32	1,313	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
112	1	124	24	261	71,447	7	650	31	3,250	15	763	32	1,313	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3

WEST VIRGINIA.

3,370	172	924	31	4,497	$1,298,316	73	$7,340	463	$39,140	19	404	20	466	
3	.....	.....	.....	3	375	.....	.....	.....	.....	.....	.....	.....	.....	1
60	10	30	.....	100	53,000	1	100	12	900	2	43	2	43	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
74	.....	.....	.....	74	22,310	.....	.....	.....	.....	.....	.....	.....	.....	4
2	.....	.....	.....	2	500	.....	.....	.....	.....	.....	.....	.....	.....	5
596	17	237	4	854	259,560	5	650	57	6,200	.....	.....	.....	.....	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
4	.....	.....	.....	4	440	.....	.....	.....	.....	.....	.....	.....	.....	8
37	.....	.....	.....	37	12,350	.....	.....	.....	.....	.....	.....	.....	.....	9
182	18	34	7	241	50,781	6	875	37	2,800	1	40	1	40	10
974	47	317	9	1,347	361,321	18	1,950	163	13,690	10	206	11	226	11
4	.....	.....	.....	4	960	.....	.....	.....	.....	.....	.....	.....	.....	12
116	4	28	.....	148	46,821	3	240	17	1,400	.....	.....	.....	.....	13
112	.....	7	3	122	41,550	.....	.....	.....	.....	.....	.....	.....	.....	14
206	17	55	1	279	91,232	7	625	64	5,050	4	95	3	105	15
96	.....	3	.....	99	36,780	6	750	.....	.....	.....	.....	.....	.....	16
24	.....	.....	.....	24	5,021	.....	.....	.....	.....	.....	.....	.....	.....	17
339	.....	27	.....	366	134,087	20	1,600	34	3,300	.....	.....	.....	.....	18
7	.....	.....	.....	7	3,000	.....	.....	.....	.....	.....	.....	.....	.....	19
167	35	48	.....	250	78,686	1	25	34	2,200	1	6	2	20	20
190	10	100	.....	300	50,000	3	200	23	1,600	.....	.....	.....	.....	21
7	.....	.....	.....	7	760	.....	.....	.....	.....	.....	.....	.....	.....	22
4	.....	.....	.....	4	1,500	.....	.....	.....	.....	.....	.....	.....	.....	23
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24
145	14	38	7	204	38,482	3	325	22	2,000	1	14	1	32	25
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26
4	.....	.....	.....	4	600	.....	.....	.....	.....	.....	.....	.....	.....	27
17	.....	.....	.....	17	8,200	.....	.....	.....	.....	.....	.....	.....	.....	28

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

VIRGINIA.

	Counties.	Number of hoisting-machines.	Number of drainage-machines.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.
		22	23	24	25	26	27	28	29
							Cords.	*Linear feet.*	*Feet, B. M.*
	The State	13	3	$1,336	$10,278	$11,614		110,540	
1	Botetourt								
2	Chesterfield	13	3	1,336	10,278	11,614		110,540	
3	Montgomery								

WEST VIRGINIA.

	The State	41	15	$30,035	$221,011	$251,046		1,819,453	720,181
1	Barbour			10	47	57			
2	Boone	1	1		6,574	6,574		15,000	100,000
3	Braxton								
4	Brooke			367	1,825	2,192			
5	Doddridge			8	38	46			
6	Fayette	1		5,514	45,347	50,861		992,660	158,000
7	Gilmer								
8	Grant			8	38	46			
9	Hancock			200	997	1,197			
10	Harrison	2		3,294	11,672	14,966		32,050	
11	Kanawha	10	11	9,283	65,931	75,214		251,443	462,181
12	Lewis			16	83	99			
13	Marion			1,432	8,314	9,746		65,000	
14	Marshall	23		296	12,660	12,456		98,400	
15	Mason	3	1	2,510	10,018	12,528		109,150	
16	Mineral			14	5,991	6,005		30,700	
17	Monongahela			126	628	754			
18	Ohio			990	27,757	28,747		120,500	
19	Pleasant			38	190	228			
20	Preston	1	1	4,022	10,276	14,298		55,550	
21	Putnam			1,687	3,513	5,200		49,000	
22	Randolph			13	66	79			
23	Ritchie			26	131	157			
24	Roane								
25	Taylor		1	17	8,093	8,110			
26	Upshur								
27	Wetzel			8	38	46			
28	Wood			156	784	940			

TABLE 29.—*Production of bituminous coal east of the 100th meridian, by states and counties*—Continued.

VIRGINIA.

FARMERS' DIGGINGS.						
Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.	Remarks.	
30	31	32	33	34		
	Tons.					
13	2,559	$6,965	50	$4,305	The remarks for West Virginia apply here, except that the amount to be added to "Materials" for half feed of horses and mules during idle time is $394, and the amount to be deducted from "wages" is $426.	
1	62	300	3	150		1
						2
12	2,497	6,665	47	4,155		3

WEST VIRGINIA.

774	47,275	$41,824	828	$19,836	*Acres* are not always given. *Materials:* To the original returns has been added throughout for feed $6 per working-month per head; also for miners' oil, and sharpening and repairing tools, 4½ cents per ton. To the aggregate materials for the State may be added for half feed of horses and mules during idle time, $4,847. *Wages:* Original returns unaltered. It is probable however that they generally represent gross earnings; if so, the following amounts should be deducted for miners' powder, oil, and for sharpening and repairing tools: Boone county, $1,008; Fayette county, $15,845; Harrison county, $7,392; Kanawha county, $19,106; Marion county, $4,977; Marshall county, $2,676; Mason county, $6,499; Mineral county, $2,762; Ohio county, $9,267; Preston county, $9,332; Putnam county, $2,205; Taylor county, $4,553; making in all, $85,122, and leaving total wages for the state, $1,213,194. *Powder:* Wherever used but not returned has been estimated at 2½ cents a ton and added to materials. *Capital—Real Estate:* When not returned and acreage omitted has been estimated as equal to the royalty on six full years' production.	
59	2,411	2,045	60	303		1
						2
39	1,312	1,131	39	1,563		3
						4
40	954	1,290	40	537		5
1	24	24	1	15		6
33	1,082	895	34	443		7
19	591	774	19	347		8
						9
153	11,388	9,115	173	4,424		10
4	308	279	4	156		11
70	3,311	3,540	75	1,768		12
33	3,762	2,490	39	1,231		13
						14
						15
9	440	431	11	215		16
45	8,237	6,622	53	3,370		17
						18
						19
86	5,768	6,099	94	2,941		20
						21
13	406	591	13	283		22
29	559	642	29	329		23
42	798	1,140	42	567		24
33	3,003	2,191	36	1,069		25
49	1,892	1,349	49	687		26
						27
17	1,020	1,176	17	588		28

TABLE 30.—*Production of bituminous coal, east of the 100th meridian, by states.*

A summary of Table 29.

NOTE.—With the exception of columns 5 and 6, in which the regular and irregular product are combined, all the statistics in columns 1 to 29, both inclusive, relate to regular establishments only.

	States.	Number of counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.	Total wages paid.
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
				Tons.	Tons.		Tons.								
	Total	314	2,943	74,153,963	40,301,758	$49,045,398	41,218,327	$50,137,603	$93,517,464	76,512	5,366	13,842	755	96,475	$30,707,099
1	Alabama	6	19	451,622	322,934	475,559	323,972	476,911	772,858	850	21	625	17	1,513	328,788
2	Arkansas	4	14	57,440	14,778	33,535	14,778	33,535	15,600	98	2	22	8	130	20,850
3	Georgia	1	2	165,000	154,644	231,605	154,644	231,605	441,745	185	.....	257	.....	442	85,179
4	Illinois	46	590	13,808,709	6,089,514	8,739,755	6,115,377	8,779,832	10,654,261	13,128	950	2,152	71	16,301	6,035,919
5	Indiana	19	216	3,110,983	1,449,496	2,143,093	1,454,327	2,150,258	2,304,720	3,748	171	570	7	4,496	1,405,164
6	Iowa	25	227	3,896,895	1,442,333	2,473,155	1,461,116	2,507,453	2,778,937	3,994	210	808	12	5,024	1,554,696
7	Kansas	24	189	1,140,518	763,597	1,498,168	771,442	1,517,444	767,994	3,142	181	288	6	3,617	758,980
8	Kentucky	49	65	2,435,776	935,857	1,123,046	946,288	1,134,960	1,968,527	1,958	122	679	67	2,826	667,474
9	Maryland	2	32	4,532,822	2,227,844	2,584,455	2,228,917	2,585,537	13,165,557	2,660	475	505	37	3,677	1,370,079
10	Michigan	2	6	141,800	100,800	224,500	100,800	224,500	66,800	295	65	51	1	412	146,000
11	Missouri	35	144	1,120,112	543,990	1,037,100	844,304	1,464,425	389,315	2,096	238	253	12	2,599	642,772
12	Nebraska	1	1	400	200	750	200	750	500	5	.....	.....	.....	5	200
13	North Carolina	1	1	700	350	400	350	400	40,170	2	.....	1	1	4	300
14	Ohio	30	618	12,093,880	5,932,853	7,629,488	6,008,595	7,719,667	13,652,484	13,626	755	1,852	98	16,331	5,100,567
15	Pennsylvania	29	666	26,229,031	18,604,988	18,157,151	18,425,163	18,567,129	38,709,344	26,550	1,941	4,489	268	33,248	10,863,583
16	Tennessee	9	20	746,050	494,491	628,954	495,131	629,724	1,708,968	693	62	242	95	1,092	336,765
17	Virginia	3	4	105,740	40,520	92,837	43,079	99,802	329,000	112	1	124	24	261	71,447
18	West Virginia	28	129	4,116,485	1,782,569	1,971,847	1,829,844	2,013,671	5,750,674	3,370	172	924	31	4,497	1,298,316

	States.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	STEAM-POWER. Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	Number of hoisting-machines.	Number of drainage-machines.
		14	15	16	17	18	19	20	21	22	23
	Total	1,892	$173,179	7,116	$649,213	812	24,696	1,178	33,024	1,040	729
1	Alabama	5	450	66	6,100	12	425	20	555	13	11
2	Arkansas	.....	.....	.....	.....	3	35	1	.....	7	5
3	Georgia	.....	.....	54	2,040	.....	.....	1	20	1	1
4	Illinois	426	28,675	1,078	77,716	286	8,294	345	9,925	393	175
5	Indiana	67	3,655	341	18,502	65	1,717	78	2,729	73	79
6	Iowa	179	10,925	338	23,723	57	1,445	54	1,932	141	56
7	Kansas	.....	.....	.....	.....	4	120	5	.....	59	26
8	Kentucky	28	2,010	348	23,897	18	522	23	738	14	11
9	Maryland	301	37,094	31	3,130	7	860	17	850	17	5
10	Michigan	.....	.....	.....	.....	6	285	14	.....	6	7
11	Missouri	.....	.....	.....	.....	13	518	14	.....	45	17
12	Nebraska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	North Carolina	1	50	.....	.....	.....	.....	.....	.....	1	.....
14	Ohio	319	27,090	1,228	91,165	131	3,835	227	5,296	120	131
15	Pennsylvania	484	55,040	3,019	345,625	170	5,301	321	9,048	96	179
16	Tennessee	2	200	139	14,925	6	132	6	152	.....	
17	Virginia	7	650	31	3,250	15	763	32	1,313	13	3
18	West Virginia	73	7,340	463	39,140	19	404	20	466	41	15

Indian territory was not canvassed by the census agents, and no returns of the coal production from that region were received. There were produced there in the census year, however, as has since been learned, 2,943,015 bushels of coal and 48,400 bushels of coke. (The coke was made from slack, and is not included in the previous figures.)

Estimating the yield of coke at 60 per cent., and the weight of a bushel of coal at 80 pounds, this would equal 120,947 net tons.

No other data in reference to this production were obtainable.

TABLE 30.—*Production of bituminous coal, east of the 100th meridian, by states*—Continued.

	States.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of wood used for fuel.	Amount of unsawed lumber.	Amount of sawed lumber.	FARMERS' DIGGINGS. Number of diggings.	Product, census year.	Value of product.	Number of persons employed.	Wages paid.
		24	25	26	27	28	29	30	31	32	33	34
					Cords.	*Linear feet.*	*Feet, B. M.*		*Tons.*			
	Total	$963,313	$3,698,349	$4,661,662	17,305	63,318,996	10,372,462	5,146	916,569	$1,092,205	8,922	$570,040
1	Alabama	11,100	37,483	48,583	212	561,500		7	1,088	1,352	20	925
2	Arkansas	25	1,110	1,135	54							
3	Georgia	3,775	5,725	9,500	658							
4	Illinois	267,730	528,419	796,149	2,439	15,299,053	484,000	165	25,863	49,077	262	25,761
5	Indiana	56,151	102,453	158,604	155	2,736,749	1,290,683		4,831	7,165	47	3,850
6	Iowa	116,970	132,850	249,820		3,743,100	19,250	68	18,783	34,298	148	25,145
7	Kansas	12,125	35,360	47,485	947			81	7,845	19,276	241	9,247
8	Kentucky	41,018	54,977	95,995		875,116	109,000	73	10,431	11,914	93	8,080
9	Maryland	40	194,902	194,942		1,379,444		15	1,073	1,082	17	532
10	Michigan	4,700	3,050	7,750	375							
11	Missouri	3,282	52,474	55,756	9,511			90	300,314	427,325	3,125	155,149
12	Nebraska	5	5	10								
13	North Carolina		50	50								
14	Ohio	210,453	720,845	931,298	2,397	4,135,378	378,697	691	75,742	90,179	252	56,840
15	Pennsylvania	193,506	1,561,096	1,754,602	557	32,246,463	6,574,651	3,166	420,175	409,978	3,932	259,795
16	Tennessee	11,062	36,261	47,323		412,200	796,000	3	640	770	7	575
17	Virginia	1,336	10,278	11,614		110,540		13	2,559	6,965	50	4,305
18	West Virginia	30,035	221,011	251,046		1,819,453	720,181	774	47,275	41,824	828	19,836

TABLE 31.—*Production of semi-anthracite coal.*

PENNSYLVANIA.

Counties.	Number of establishments.	Maximum yearly capacity of production.	Product of establishments, census year.	Value of product of establishments.	Total product, census year.	Value of total product.	Total capital, real and personal, invested.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total number of employés.
	1	2	3	4	5	6	7	8	9	10	11	12
		Tons.	*Tons.*		*Tons.*							
The State	1	112,000	70,560	$110,000	70,560	$110,000	$1,112,770	10	130	20	40	200
Sullivan	1	112,000	70,560	110,000	70,560	110,000	1,112,770	10	130	20	40	200

Counties.	Total wages paid.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	STEAM-POWER. Number of engines.	Horse-power of engines.	Number of boilers.	Horse-power of boilers.	Value of explosives.	Value of all other materials.	Total value of all materials.	Amount of unsawed lumber.
	13	14	15	16	17	18	19	20	21	22	23	24	25
													Lin. feet.
The State	$66,000	4	$500	34	$3,000	1	25	1	40	$2,201	$7,199	9,400	70,560
Sullivan	66,000	4	500	34	3,000	1	25	1	40	2,201	7,199	9,400	70,560

TABLE 32.—*Production of bituminous coal and lignite west of the 100th meridian, by states and counties.*

	Counties.	Number of establishments.	Number of acres of coal lands.	Maximum yearly capacity of production.	Total product, census year.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total employés.	Miners.	Laborers.	Administrative force.	Total wages paid.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	CALIFORNIA.														
				Tons.	*Tons.*										
	The State	6	2,960	239,927	236,950	$663,013	650	8	93	.....	751	478	255	18	$321,950
1	Amador	2	1,400	85,680	85,680	153,000	50	.....	10	.....	60	50	7	3	28,000
2	Contra Costa	3	1,560	151,247	150,486	507,213	592	8	81	.....	681	420	247	14	293,209
3	Los Angeles	1	.....	3,000	784	2,800	8	.....	2	.....	10	8	1	1	741
	COLORADO.														
	The State	25	23,592	638,233	462,747	$1,041,350	1,133	.....	301	.....	1,434	1,133	227	74	$714,714
1	Boulder	8	3,202	183,690	172,740	441,745	314	.....	86	.....	400	314	62	24	303,000
2	Fremont	1	3,300	88,323	88,323	220,800	200	.....	26	.....	226	200	20	6	111,600
3	Gunnison	1	320	10,000	200	1,000	2	.....	.....	.....	2	2	.....	.....	400
4	Jefferson	5	.....	130,500	20,650	63,025	74	.....	44	.....	118	74	35	9	25,375
5	Huerfano	2	2,810	55,000	26,930	52,900	120	.....	25	.....	145	120	20	5	36,675
6	Las Animas	5	9,000	105,312	103,032	132,280	203	.....	46	.....	249	203	29	17	137,700
7	Park	1	480	16,128	4,032	16,200	150	.....	57	.....	207	150	50	7	46,200
8	Weld	2	4,480	40,280	46,840	113,400	70	.....	17	.....	87	70	11	6	54,364
	MONTANA TERRITORY.														
	The Territory	1	.....	1,344	224	$800	3	.....	.....	.....	3	3	.....	.....	$400
1	Gallatin	1	.....	1,344	224	800	3	.....	.....	.....	3	3	.....	.....	400
	OREGON.														
	The State	2	2,649	43,205	43,205	$97,810	63	.....	13	.....	76	52	21	3	$68,017
1	Coos	2	2,649	43,205	43,205	97,810	63	.....	13	.....	76	52	21	3	68,017
	UTAH TERRITORY.														
	The Territory	6	4,440	31,544	14,748	$33,645	79	.....	12	.....	91	70	21	.....	$25,675
1	Summit	3	200	27,844	12,048	25,845	68	.....	12	.....	80	59	21	.....	20,700
2	San Pete	2	4,080	3,400	2,400	7,200	8	.....	.....	.....	8	8	.....	.....	3,175
3	Iron	1	160	300	300	600	3	.....	.....	.....	3	3	.....	.....	1,800
	Irregular product, 500 tons; value, $1,125 (Iron county?).														
	WASHINGTON TERRITORY.														
	The Territory	5	2,600	161,708	145,015	$389,046	103	.....	65	.....	168	103	44	21	$143,754
1	King	3	2,120	158,796	142,103	380,544	93	.....	50	.....	143	93	34	16	135,868
2	Pierce	1	.....	261	261	1,401	3	.....	5	.....	8	3	5	.....	1,926
3	Thurston	1	480	2,651	2,651	7,101	7	.....	10	.....	17	7	5	5	5,960
	WYOMING TERRITORY.														
	The Territory	6	1,200	917,280	589,595	$1,080,451	860	.....	149	.....	1,009	830	159	20	$579,566
1	Carbon	1	.....	96,320	95,954	171,346	75	.....	12	.....	87	75	8	4	100,451
2	Crook	1	.....	.....	22	60	3	.....	.....	.....	3	3	.....	.....	750
3	Sweetwater	1	.....	336,000	249,042	445,790	385	.....	41	.....	426	355	65	6	229,192
4	Uintah	3	1,200	484,960	243,977	463,235	397	.....	96	.....	493	397	86	10	249,173

TABLE 32.—*Production of bituminous coal and lignite west of the* 100*th meridian, by states and counties*—Continued.

CALIFORNIA.

	Counties.	CAPITAL. Real estate.	Plant.	Working capital.	Total capital.	Value of explosives.	Value of all materials.	Number of hoisting-machines.	Number of drainage-machines.	STEAM-POWER. Number of engines.	Value of engines.	Horse-power of engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Value of all machinery.
		15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	The State	$596,000	$535,500	$107,931	$1,239,431	$2,367	$44,013	10	12	8	$19,000	295	32	$45,000	850	$77,500
1	Amador	180,000	9,000	2,450	191,450	.....	500	2	1	2	4,000	60	2	2,000	100	7,500
2	Contra Costa	411,000	524,000	104,956	1,039,956	1,655	42,592	8	11	6	15,000	235	30	43,000	750	70,000
3	Los Angeles	5,000	2,500	525	8,025	712	921	.....	.....	.....	.....	.....	.....	.....	.....	.....

COLORADO.

	The State	$5,448,100	$328,600	$162,550	$5,939,250	$11,673	$114,576	23	19	20	$44,000	749	25	$33,750	1,140	$100,650
1	Boulder	588,700	76,500	76,550	741,750	7,418	50,702	8	5	4	13,500	210	4	7,000	250	26,950
2	Fremont	3,380,000	10,000	10,000	3,400,000	800	8,378	1	.....	1	3,000	50	1	2,000	40	6,000
3	Gunnison	9,800	100	100	10,000	4	40	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	Jefferson	35,100	29,700	6,700	71,500	1,318	7,080	4	2	4	11,000	244	6	6,250	300	19,500
5	Huerfano	140,500	20,100	4,600	165,200	490	5,879	1	2	1	2,000	20	3	4,500	120	10,000
6	Las Animas	893,000	106,500	34,000	1,033,500	75	9,033	.....	1	1	2,000	20	1	1,500	40	5,500
7	Park	48,000	62,000	24,000	134,000	40	12,490	4	6	4	8,000	110	6	9,000	240	23,000
8	Weld	353,000	23,700	6,600	383,300	1,528	20,374	5	3	5	4,500	95	4	3,500	150	9,700

MONTANA TERRITORY.

	The Territory	$7,200	$5,100	$250	$12,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	Gallatin	7,200	5,100	250	12,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

OREGON.

	The State	$105,000	$115,023	$6,500	$226,523	$1,928	$8,567	.....	.....	1	$5,000	60	1	$1,000	60	$13,000
1	Coos	105,000	115,023	6,500	226,523	1,928	8,567	.....	.....	1	5,000	60	1	1,000	60	13,000

UTAH TERRITORY.

	The Territory	.....	$23,000	$11,514	.....	.....	$2,582	.....	.....	4	$12,000	48	5	$6,000	200	$21,500
1	Summit	.....	17,000	10,114	.....	.....	.....	.....	.....	3	9,000	39	4	4,500	150	16,500
2	San Pete	.....	5,500	1,000	.....	.....	.....	.....	.....	1	3,000	9	1	1,500	50	5,000
3	Iron	.....	500	400	.....	.....	2,582	.....	.....	.....	.....	.....	.....	.....	.....	.....

WASHINGTON TERRITORY.

	The Territory	$232,000	$87,721	$15,700	$335,421	$10,698	$21,203	2	2	4	$6,000	115	4	$4,500	140	$15,500
1	King	212,000	81,721	14,500	308,221	10,650	18,644	1	2	3	5,000	85	3	4,000	100	13,000
2	Pierce	.....	3,000	200	3,200	20	889	1	.....	1	1,000	30	1	500	40	2,500
3	Thurston	20,000	3,000	1,000	24,000	28	1,670	.....	.....	.....	.....	.....	.....	.....	.....	.....

WYOMING TERRITORY.

	The Territory	$470,000	$179,398	$77,000	$726,398	$36	$1,072	9	8	9	$18,000	228	19	$25,000	475	$59,000
1	Carbon	75,000	9,000	8,500	92,500	.....	885	1	2	1	2,000	25	4	4,000	100	8,000
2	Crook	.....	1,127	1,000	2,127	36	187	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	Sweetwater	150,000	35,000	25,500	210,500	.....	.....	5	2	5	10,000	125	10	15,000	200	32,000
4	Uintah	245,000	134,271	42,000	421,271	.....	.....	3	4	3	6,000	78	5	6,000	125	19,000

TABLE 32.—*Production of bituminous coal and lignite west of the 100th meridian, by states and counties*—Continued

	Counties.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Amount of wood used for fuel.	Value of cord wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.
		30	31	32	33	34	35	36	37
						Cords.		*Linear feet.*	
	CALIFORNIA.								
	The State	22	$2,200	22	$2,200			1,879,500	$18,907
1	Amador							2,000	132
2	Contra Costa	22	2,200	22	2,200			1,868,800	18,688
3	Los Angeles							8,700	87
	COLORADO.								
	The State			96	$9,600			1,100,305	$33,837
1	Boulder			29	2,900			319,680	11,594
2	Fremont			30	3,000			100,000	2,300
3	Gunnison								
4	Jefferson							51,625	1,023
5	Huerfano			10	1,000			68,000	1,220
6	Las Animas			17	1,700			161,000	3,600
7	Park							300,000	12,000
8	Weld			10	1,000			100,000	2,100
	MONTANA TERRITORY.								
	The Territory								
1	Gallatin								
	OREGON.								
	The State			14	$1,400				
1	Coos			14	1,400				
	UTAH TERRITORY.								
	The Territory	3	$150					243,950	$731
1	Summit	2	100					200,750	602
2	San Pete	1	50					38,400	115
3	Iron							4,800	14
	WASHINGTON TERRITORY.								
	The Territory			20	$2,000	300	$675	30,060	$902
1	King			20	2,000	300	675	4,750	121
2	Pierce							2,700	69
3	Thurston							22,610	712
	WYOMING TERRITORY.								
	The Territory			42	$4,200			7,000	$140
1	Carbon			10	1,000				
2	Crook							7,000	140
3	Sweetwater			10	1,000				
4	Uintah			22	2,200				

TABLE 33.—*Production of bituminous coal and lignite west of the 100th meridian, by states.*

[A summary of Table 32.]

	States and territories.	Number of counties.	Number of establishments.	Number of acres of coal lands.	Maximum yearly capacity of production.	Total product, census year.	Value of total product.	EMPLOYÉS. Men employed below ground.	Boys employed below ground.	Men employed above ground.	Boys employed above ground.	Total employés.	Miners.	Laborers.	Administrative force.	Total wages paid.
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Tons.	*Tons.*										
	Total	23	51	37,441	2,033,241	1,492,484	$3,306,115	2,891	8	633	.....	3,532	2,669	727	136	$1,854,076
1	California	3	6	2,960	239,927	236,950	663,013	650	8	93	.....	751	478	255	18	321,950
2	Colorado	8	25	23,592	638,233	462,747	1,041,350	1,133	.....	301	.....	1,434	1,133	227	74	714,714
3	Montana territory	1	1	.....	1,344	224	800	3	.....	.....	.....	3	3	.....	.....	400
4	Oregon	1	2	2,649	43,205	43,205	97,810	63	.....	13	.....	76	52	21	3	68,017
5	Utah territory	3	6	4,440	31,544	14,748	33,645	79	.....	12	.....	91	70	21	.....	25,675
6	Washington territory	3	5	2,600	161,708	145,015	389,046	103	.....	65	.....	168	103	44	21	143,754
7	Wyoming territory	4	6	1,200	917,280	589,595	1,080,451	860	.....	149	.....	1,009	830	159	20	579,566

	States and territories.	CAPITAL. Real estate.	Plant.	Working capital.	Total capital.	Value of explosives.	Total value of all materials.	Number of hoisting-machines.	Number of drainage-machines.	STEAM-POWER. Number of engines.	Value of engines.	Horse-power of engines.	Number of boilers.	Value of boilers.	Horse-power of boilers.	Value of all machinery.
		15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	Total	$6,858,300	$1,274,342	$381,445	$8,479,573	$26,702	$192,013	44	41	46	$104,000	1,495	86	$115,250	2,865	$287,150
1	California	596,000	535,500	107,931	1,239,431	2,367	44,013	10	12	8	19,000	295	32	45,000	850	77,500
2	Colorado	5,448,100	328,600	162,550	5,939,250	11,673	114,576	23	19	20	44,000	749	25	33,750	1,140	100,650
3	Montana territory	7,200	5,100	250	12,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	Oregon	105,000	115,023	6,500	226,523	1,928	8,567	.....	.....	1	5,000	60	1	1,000	60	13,000
5	Utah territory	.....	23,000	11,514	.....	.....	2,582	.....	.....	4	12,000	48	5	6,000	200	21,500
6	Washington territory	232,000	87,721	15,700	335,421	10,698	21,203	2	2	4	6,000	115	4	4,500	140	15,500
7	Wyoming territory	470,000	179,398	77,000	726,398	36	1,072	9	8	9	18,000	228	19	25,000	475	59,000

	States and territories.	Number of horses.	Value of horses.	Number of mules.	Value of mules.	Amount of wood used for fuel.	Value of cord-wood.	Amount of unsawed lumber (other than for fuel).	Value of unsawed lumber.
		30	31	32	33	34	35	36	37
						Cords.		*Linear feet.*	
	Total	25	$2,350	194	$19,400	300	$675	3,260,815	$54,517
1	California	22	2,200	22	2,200	.....	.....	1,879,500	18,907
2	Colorado	.....	.....	96	9,600	.....	.....	1,100,305	33,837
3	Montana territory	.....	.....	.....	.....	.....	.....	.....	.....
4	Oregon	.....	.....	14	1,400	.....	.....	.....	.....
5	Utah territory	3	150	.....	.....	.....	.....	243,950	731
6	Washington territory	.....	.....	20	2,000	300	675	30,060	906
7	Wyoming territory	.....	.....	42	4,200	.....	.....	7,000	140

GENERAL ANALYSIS OF THE BITUMINOUS COAL STATISTICS. (a)

By Charles F. Johnson, Jr.

Table No. 34.—*Production of bituminous coal by states east of the 100th meridian.*

	Name of state.	Number of counties.	Number of establishments.	Maximum capacity of yearly production, tons.	Product of establishments census year, tons.	Value of product at mines.	Irregular product, tons.	Total product census year, tons.	Value of total product at mines.	Value of materials used in mines census year.	Wages paid to all classes of labor.
		1	2	3	4	5	6	7	8	9	10
	Total	314	2,943	74,153,963	40,301,758	$49,045,398	916,569	41,228,328	$50,137,603	$4,661,662	$30,707,099
1	Alabama	6	19	451,622	322,934	475,559	1,038	323,972	476,911	48,583	328,788
2	Arkansas	4	14	57,440	14,778	33,535	.....	14,778	33,535	1,135	20,850
3	Georgia	1	2	165,000	154,644	231,605	.....	154,644	231,605	9,500	85,179
4	Illinois	46	590	13,808,709	6,089,514	8,739,755	25,863	6,115,377	8,779,832	796,149	6,035,919
5	Indiana	19	216	3,110,983	1,449,496	2,143,693	4,831	1,454,327	2,150,258	158,604	1,405,164
6	Iowa	25	227	3,896,895	1,442,333	2,473,155	18,783	1,461,116	2,507,453	249,820	1,554,696
7	Kansas	24	189	1,140,518	763,597	1,498,168	7,845	771,442	1,517,444	47,485	758,980
8	Kentucky	49	65	2,435,776	935,857	1,123,046	10,431	946,288	1,134,960	95,995	687,474
9	Maryland	2	32	4,532,822	2,227,844	2,584,455	1,073	2,228,917	2,585,537	194,942	1,370,079
10	Michigan	2	6	141,800	100,800	224,500	.....	100,800	224,500	7,750	146,000
11	Missouri	35	144	1,120,112	543,990	1,037,100	300,314	844,304	1,464,425	55,756	642,772
12	Nebraska	1	1	400	200	750	.....	200	750	10	200
13	North Carolina	1	1	700	350	400	.....	350	400	50	300
14	Ohio	30	618	12,093,880	5,932,853	7,629,488	75,742	6,008,595	7,719,667	931,298	5,100,547
15	Pennsylvania	29	666	26,229,031	18,004,988	18,157,151	420,175	18,425,163	18,567,129	1,754,602	10,863,583
16	Tennessee	9	20	746,050	494,491	628,954	640	495,131	629,724	47,323	336,765
17	Virginia	3	4	105,740	40,520	92,837	2,559	43,079	99,802	11,614	71,447
18	West Virginia	28	129	4,116,485	1,782,569	1,971,847	47,275	1,829,844	2,013,671	251,046	1,298,316

	Name of state.	Men employed above ground.	Men employed below ground.	Boys under 16 employed above ground.	Boys under 16 employed below ground.	Total employés.	Number of steam engines.	Horse-power of steam engines.	Value of all machinery including engines.	Value of explosives used, census year.	Amount employed as working capital.
		11	12	13	14	15	16	17	18	19	20
	Total	13,842	76,512	755	5,366	96,475	812	24,696	$2,403,211	$963,313	$8,191,900
1	Alabama	625	850	17	21	1,513	12	425	46,400	11,100	111,500
2	Arkansas	22	98	8	2	130	3	35	.....	25	.....
3	Georgia	257	185	.....	.....	442	.....	.....	.....	3,775	30,745
4	Illinois	2,152	13,128	71	950	16,301	286	8,294	597,184	267,730	1,162,635
5	Indiana	570	3,748	7	171	4,496	65	1,717	146,908	56,151	348,665
6	Iowa	808	3,994	12	210	5,024	57	1,445	126,218	116,970	273,350
7	Kansas	288	3,142	6	181	3,617	4	120	.....	12,125	.....
8	Kentucky	679	1,958	67	122	2,826	18	522	51,150	41,018	276,000
9	Maryland	505	2,660	37	475	3,677	7	860	129,050	40	901,300
10	Michigan	51	295	1	65	412	6	235	.....	4,700	.....
11	Missouri	258	2,096	12	238	2,599	13	518	.....	3,282	.....
12	Nebraska	.....	5	.....	.....	5	.....	.....	.....	5	.....
13	North Carolina	1	2	1	.....	4	.....	.....	25	.....	70
14	Ohio	1,852	13,626	98	755	16,331	131	3,835	386,904	210,453	1,177,328
15	Pennsylvania	4,489	26,550	268	1,941	33,248	170	5,391	720,189	193,506	3,460,867
16	Tennessee	242	693	95	62	1,092	6	132	10,750	11,062	65,750
17	Virginia	124	112	24	1	261	15	763	75,100	1,336	26,500
18	West Virginir	924	3,370	31	172	4,497	19	404	113,333	30,035	357,250

(a) Prepared for Census Bulletin No. 273. The figures have been corrected where necessary to make them agree with the final results.

TABLE No. 34.—*Production of bituminous coal by states east of the 100th meridian*—Continued.

	Name of state.	Value of plant.	Value of real estate.	Total capital employed and classified invested in establishments. (a)	Tons paying royalty.	Amount paid as royalty.	Acres coal land worked out.	Acres coal land unworked, attached to working collieries.	Acres coal land unspecified.	Grand total of capital, classified and unclassified, invested in regular establishments. (a)	Acres available coal lands attached to working establishments.
		21	22	23	24	25	26	27	28	29	30
	Total	$19,453,107	$62,354,034	$89,999,101	13,689,864	$1,964,076	56,101	206,151	204,491	$93,517,464	410,642
1	Alabama	270,833	328,475	705,808	86,494	14,227	155	2,555	2,440	772,858	4,995
2	Arkansas								81	15,000	81
3	Georgia	311,000	100,000	441,745	15,000	1,875	62	16,028		441,745	16,028
4	Illinois	3,153,457	6,100,460	10,416,552	2,763,857	238,258	19,143	25,502	29,549	10,654,261	55,051
5	Indiana	773,445	1,146,859	2,268,969	899,356	137,311	2,884	8,000	2,407	2,304,720	10,407
6	Iowa	860,672	1,644,915	2,778,937	684,754	160,157	594	3,502	16,626	2,778,937	20,128
7	Kansas								1,600	767,994	1,600
8	Kentucky	732,252	939,385	1,947,637	213,490	29,017	1,235	30,748	3,887	1,968,537	34,635
9	Maryland	853,957	11,387,000	13,142,257	412,341	46,658	3,262	14,249	863	13,165,557	15,112
10	Michigan								107	66,800	107
11	Missouri								3,715	389,315	3,715
12	Nebraska								1	500	1
13	North Carolina	100	40,000	40,170					1,200	40,170	1,200
14	Ohio	3,258,581	8,529,931	12,965,840	2,630,108	458,468	9,984	32,988	24,651	13,652,484	58,639
15	Pennsylvania	7,242,524	27,152,403	37,855,794	5,099,817	728,735	17,730	60,814	57,497	38,709,344	118,311
16	Tennessee	415,371	1,222,847	1,703,968	141,818	35,390			23,743	1,708,968	23,743
17	Virginia	133,000	169,500	329,000	17,878	2,272			230	329,000	230
18	West Virginia	1,447,915	3,597,259	5,402,424	724,951	111,708	1,052	10,765	35,894	5,750,674	46,659

(a) The capital of all the mines in the states canvassed only by the regular census enumerators (*i. e.*, Arkansas, Kansas, Michigan, Missouri, and Nebraska), and of some of the small mines in the states canvassed from my office, was not classified into *value of plant, value of real estate*, etc., but was returned only under the heading *total capital, real and personal, invested*. In column 23 is given for each state the total of the classified capital, and to this is added, in column 29, the "unclassified capital" above referred to. Column 29 gives then the total capital invested in regular establishments. It will be seen that out of a total capital of 93½ million dollars reported, the capital representing nearly 90 million dollars was classified.—R. PUMPELLY.

Column No. 2 gives the number of separate individual "establishments" from which schedules have been received. As a rule, each schedule received represents what is ordinarily called "a mine", but in some cases one schedule necessarily contains all the data of a company which works one or more shafts not connected underground, and keeps no separate record of the product or labor of each of their mine-openings. Such cases—though from the point of view of a mine engineer they might represent two or more mines—we have been obliged to consider as one "industrial establishment". In the anthracite field this question as to what should constitute the industrial unit in the census report cannot arise, since the word "colliery" has a definite signification, *i. e.*, all the mine openings whose product goes to a single breaker building and is there mixed before delivery. No such absolute distinguishing criterion exists in the iron-ore and bituminous-coal industry, but the term "industrial establishment" must be taken to mean an organization, the managers of which keep a record in such a manner that the data required for the census can be obtained for it separately. There are, however, not more than five or six cases where any doubt on this point can arise.

Column 3, headed "Maximum capacity", represents the number of tons which the operators claim could be raised yearly from the present openings with the present facilities, if the market would take it. It is unexpectedly large, and possibly in some cases based on too sanguine estimates of capacity. As will be noticed, the average time run was only nine months of the year, which would indicate that the capacity of the mines was at least one-third more than the product.

Column 4 gives the production of mines supplying the general market, in tons of 2,000 pounds. It also is larger than was anticipated, but there is no reason to suppose it exaggerated. For instance, the production of Pennsylvania is given in the *Mine Inspector's Report* (see *Annual Report of the Secretary of Internal Affairs* for 1879–'80, pages 289, 362, and 410) at 18,837,962 tons. This summation is based largely on estimates, and covers the year ending December 1, 1880, thus embracing a period marked by a more active demand for coal and coke than the census year ending June 1, 1880. Our total is 18,004,988, a difference of 4.4 per cent., which is less than the natural increase between the two periods.

The 6th column is headed "Irregular product". Under this has been gathered the output of all the small operations where coal is mined in small quantities for local consumption. In many cases, in some of the bituminous fields, a farmer digs coal from the outcrop on his own farm and supplies his own, and perhaps one or two neighboring

families. This industry is analogous to the cutting of wood for domestic fuel, and has no bearing on the mining a industry of the country. The whole amount so produced is only 916,569 tons, and it might as well be disregarded hereafter. The iron ore mined in a small way eventually reaches the general market, but the coal does not. No labor is hired and no machinery is used, and the work is carried on when there is nothing else to do on the farm. Strictly speaking, no capital is employed. There were over 5,000 of these small operations or "farmers' diggings" reported, and the labor of gathering the statistics from them is entirely disproportioned to the value of the results. They average less than 125 tons yearly.

All the other columns, except the 7th, and the 8th, apply to the regular mines or "establishments" only.

In column 5 the value is taken at the "mine's mouth," or rather at the point where the product is delivered for transportation to market. b

Column 9, "Value of materials," covers mine supplies consumed, including powder, fuse, iron, steel, timber, lumber, wire, rope, etc., whether bought by the miners or by the operators.

Column 10 covers wages paid to all classes of labor during the census year, and represents the amount received by the men, less the amount paid by them for material, as powder, fuse, etc., which in many cases are charged to the miners and deducted at the end of the month from their gross wages. The necessity of making this deduction, when not already made on the return, has involved a great deal of extra labor which could not well be avoided, since the average net annual income of the miner available to the support of himself and his family is clearly one of the important items which the census should seek to ascertain with accuracy.

The meaning of the columns relating to capital has been sufficiently explained in the former bulletins on c anthracite coal, iron ore, and copper, and need not be repeated here.

An endeavor was made to ascertain the number of acres of coal lands that were worked out. This has not been altogether successful, as in many cases it was impossible to answer the question with approximate accuracy. In other cases the upper seam only was worked out over a certain area, leaving one or more below untouched. The sum of the three columns of acres is *but a very small fraction of the total available coal land.* The sum in question, 466,743 acres, represents the land attached to working collieries, and averages $133 an acre. The fields are so extensive that only those lands which have special advantages of position, ease of mining, or quality of product, have any present industrial value as mineral lands. d

TABLE No. 35.—*General average—bituminous coal.*

	Name of state.	Average price per ton of product of regular mines, at mine.	Average cost of labor per ton.	Average cost of material per ton.	Average amount left for royalty, profit, etc., per ton.	Per cent. of capital used for working capital.	Per cent. of capital in plant.	Per cent. of capital in real estate.	Average royalty paid per ton, cents.	Average yearly earnings of man, net.	Average per cent. of year worked.	Average per cent. of year idle, except from strikes.	Average per cent. of year lost in strikes.	Tons raised per man per day.	Tons raised yearly per man.	Per cent. ratio of product to maximum capacity.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Total	$1.22	$0.76	$0.12	$0.34	9.10	21.61	69.28	0.14	$328 72	75.70	17.62	6.68	1.90	431.43	54.34
1	Alabama	1.47	1.02	0.15	0.30	15.80	38.37	45.83	0.16	220 07	91.54	2.78	5.68	0.71	216.15	71.50
2	Arkansas	2.27	1.41	0.08	0.78	.....	.....	.....	.....	166 80	.....	.....	.....	.....	118.22	25.73
3	Georgia	1.50	0.55	0.06	0.89	6.96	70.40	22.64	0.125	192 71	100.00	0.00	0.00	1.17	349.87	43.67
4	Illinois	1.44	0.99	0.13	0.32	11.16	30.27	58.57	0.09	382 25	78.15	17.32	4.53	1.65	385.64	44.10
5	Indiana	1.48	0.97	0.11	0.40	15.37	34.09	50.54	0.15	318 85	74.34	21.36	4.30	1.47	328.91	46.59
6	Iowa	1.71	1.08	0.17	0.46	9.84	30.97	59.19	0.23	316 45	69.52	24.14	6.34	1.41	293.57	37.01
7	Kansas	1.96	0.99	0.06	0.91	.....	.....	.....	.....	215 41	.....	.....	.....	.....	216.63	66.93
8	Kentucky	1.20	0.73	0.10	0.37	14.17	37.60	48.23	0.14	261 68	62.00	23.60	4.40	1.84	342.61	38.42
9	Maryland	1.16	0.61	0.09	0.46	6.85	6.50	86.64	0.11	400 49	69.93	17.60	12.47	3.10	651.23	49.15
10	Michigan	2.23	1.45	0.08	0.70	.....	.....	.....	.....	385 22	.....	.....	.....	.....	265.96	71.08
11	Missouri	1.91	1.18	0.10	0.63	.....	.....	.....	.....	259 81	.....	.....	.....	.....	219.88	48.57
12	Nebraska	3.75	1.50	0.05	2.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	North Carolina	1.14	0.57	0.14	0.43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	Ohio	1.29	0.86	0.16	0.27	9.08	25.13	65.79	0.17	320 69	77.90	13.55	8.55	1.60	373.03	49.06
15	Pennsylvania	1.01	0.60	0.10	0.31	9.14	19.13	71.73	0.14	337 97	75.73	17.28	6.99	2.47	560.14	68.65
16	Tennessee	1.27	0.68	0.10	0.49	3.86	24.38	71.76	0.25	332 28	91.15	8.79	0.06	1.78	487.90	66.28
17	Virginia	2.29	1.76	0.29	0.24	8.05	40.43	51.52	0.13	287 31	61.06	38.94	0.00	0.89	162.65	38.32
18	West Virginia	1.10	0.72	0.14	0.24	6.61	26.50	66.59	0.15	295 37	69.05	23.57	7.38	1.97	465.79	43.33

a Table No. 35 contains the averages drawn from the data in Table No. 34. In estimating the day's work, yearly earnings, etc., two boys were considered the equivalent, in producing and earning capacity, of one man. The year is taken to consist of twelve months of twenty-five working days each. A very considerable amount of time has been lost in strikes—about twenty days each for every man employed. Although it is not our province to discuss the question of strikes, it may not be out of place to call attention to some of the concomitant facts. First, in the bituminous coal industry there has been an *absolute fall* in the value per ton of the product, whereas iron ore and anthracite coal have not fallen in price since the last census more than gold has, or rather after falling they recovered, which bituminous coal did not. Second, in spite of the time lost in strikes, the average yearly earnings of a man engaged in mining bituminous coal are very nearly the same as those of the iron-ore miner, being in the one $328 72 and in the other $316 08, for the country at large. Third, that in the bituminous industry the percentage b of the value of the product obtained by labor has increased nearly 1 per cent., labor obtaining in 1880 62.3 per cent. of the selling price of the product, against 61.6 per cent. in 1870. In other words, the cost of labor per ton has not fallen in quite so large a ratio as the value per ton, though both have fallen more than gold did in the same interval (see Table No. 36). This very small difference represents a gain in favor of labor of one third of a million of dollars annually, and is the more striking from the fact that wages in the Census of 1880 represent net wages, whereas it is possible that the return in the Census of 1870, which is used as a basis of comparison, may include a part of what was necessarily expended by the men for mine supplies.

TABLE 36.—*Production of bituminous coal during the census year ending May* 31, 1880, *compared with the one ending May* 31, 1870, *for mines east of the* 100*th meridian.*

		Per cent.
c	1. Gain in number of mines	122.0
	2. Gain in yearly tonnage	135.0
	3. Gain in value of yearly product	44.0
	4. Gain in value of material used	133.0
	5. Gain in amount paid as wages	46.0
	6. Gain in total number of employés	133.0
	7. Gain in total capital	54.0
	8. Decrease in value per ton	39.0
	9. Gain in tons raised per man per year	3.0
	10. Decrease in yearly earnings	36.0
d	11. Decrease in cost of labor per ton	38.0
	12. Decrease in cost of material per ton	1.0
	13. Gain in per cent. of value of the product paid for labor	0.7
	14. Gain in per cent. of value of the product paid for materials	3.9
	15. Decrease in per cent. of value of the product left for royalty, interest, profits, etc	4.6
	16. Gain in number of counties reporting	68.0

NOTE.—The above table illustrates the fact that the fall in price per ton of bituminous coal during the last decade has borne less heavily on labor than on capital. Compare 3, 6, 8, 11, and 13.

As between the bituminous coal industry and the iron-ore mining industry, the former takes from the earth a product worth 140 per cent. more, employs 205 per cent. more hands, and 46 per cent. more capital, uses 161 per cent. more materials, and pays 222 per cent. more wages. These figures are based on the returns from regular e mines, and would be slightly less if the "irregular product"—more important in the case of coal than in that of iron—were taken into consideration.

The increase in the tonnage of the iron ore mined during the census year is 136 per cent., and in that of bituminous coal 135 per cent., as compared with the census year of 1870, showing that these two great divisions of mineral production keep pace with each other, and are advancing nearly twice as fast as the production of anthracite. The reason of this is the obvious one, that in the former cases new fields are laid under contribution, from time to time, as railways are extended, whereas anthracite is restricted to its original area.

Iron is mined in 135 counties, and bituminous coal in 314 counties east of the 100th meridian.

TABLE No. 37.—*List of counties of the first class east of the* 100*th meridian, i. e., producing over* 500,000 *tons per annum.*

f	County.	State.	Tons.		County.	State.	Tons.
	Total		22,167,999	8	Tioga	Pennsylvania	938,517
				9	Perry	Ohio	913,974
1	Allegheny	Pennsylvania	4,426,871	10	Clay	Indiana	772,423
2	Westmoreland	do	3,297,390	11	Trumbull	Ohio	722,265
3	Fayette	do	2,318,728	12	La Salle	Illinois	714,787
4	Alleghany	Maryland	2,198,073	13	Will	do	611,311
5	Clearfield	Pennsylvania	1,722,711	14	Cambria	Pennsylvania	590,075
6	Washington	do	968,042	15	Columbiana	Ohio	515,602
7	Saint Clair	Illinois	956,265	16	Bradford	Pennsylvania	500,965

TABLE No. 38.—*List of counties of the second class east of the 100th meridian, i. e., producing over 250,000 tons per annum.*

	County.	State.	Tons.		County.	State.	Tons.
	Total		6,677,306	10	Hocking	Ohio	331,170
				11	Jefferson	do	324,070
1	Mercer	Pennsylvania	485,276	12	Athens	do	310,750
2	Sangamon	Illinois	427,616	13	Blair	Pennsylvania	293,834
3	Bourbon	Kansas	403,519	14	Clarion	do	286,846
4	Belmont	Ohio	399,747	15	Somerset	do	286,450
5	Kanawha	West Virginia	368,901	16	Mahaska	Iowa	283,836
6	Meigs	Ohio	359,225	17	Elk	Pennsylvania	281,151
7	Fayette	West Virginia	353,678	18	Peoria	Illinois	273,540
8	Stark	Ohio	347,820	19	Madison	do	272,927
9	Fulton	Illinois	331,449	20	Tuscarawas	Ohio	255,495

The sixteen counties of the first class furnish 54.9 per cent., and the twenty counties of the second class 16.6 per cent. of the entire product, leaving 28.5 per cent. to be spread over the remaining two hundred and seventy-eight counties. Allegheny county, Pennsylvania, produces over one-tenth, and the three leading counties of Pennsylvania nearly one-quarter of the entire product.

TABLE No. 39.—*Rank of the states east of the 100th meridian producing bituminous coal in the census year ending June 1, 1880.*

	Name of state.	Product of regular mines, tons of 2,000 pounds.	Percentage of total product.		Name of state.	Product of regular mines, tons of 2,000 pounds.	Percentage of total product.
	Total	40,301,758	100.00	9	Kansas	763,597	1.895
				10	Missouri	543,990	1.349
1	Pennsylvania	18,004,988	44.675	11	Tennessee	494,491	1.227
2	Illinois	6,089,514	15.111	12	Alabama	322,934	0.801
3	Ohio	5,932,853	14.722	13	Georgia	154,644	0.383
4	Maryland	2,227,844	5.528	14	Michigan	100,800	0.250
5	West Virginia	1,782,569	4.423	15	Virginia	40,520	0.100
6	Indiana	1,449,496	3.597	16	Arkansas	14,778	0.036
7	Iowa	1,442,333	3.579	17	Nebraska	200	.....
8	Kentucky	935,857	2.323	18	North Carolina	350	.....

The three leading states, Pennsylvania, Illinois, and Ohio, produce nearly three-fourths, and the eight leading states nearly nineteen-twentieths of the entire product.

TABLE No. 40.—*The rank of states east of the 100th meridian, as producers of bituminous coal, according to the census of 1870, was as follows:*

		Per cent. gain in 1880.
1.	Pennsylvania	131
2.	Illinois	132
3.	Ohio	135
4.	Maryland	22
5.	Missouri	13*
6.	West Virginia	194
7.	Indiana	231
8.	Iowa	447
9.	Kentucky	521
10.	Tennessee	270
11.	Virginia	34*
12.	Kansas	2217
13.	Michigan	258
14.	Alabama	2836

* Loss.

The United States, exclusive of the territories, has gained 134.4 per cent. in weight of product. The average price per ton has fallen from $1 99 to $1 22 during the past decade, the price for 1870 being, of course, reckoned in paper dollars.

a TABLE No. 41.—*Production of bituminous coal and lignite west of the 100th meridian.*

Name of state and territory.	Number of counties.	Number of establishments.	Maximum capacity of yearly production, tons.	Total product census year, tons.	Value of total product.	Value of materials used, census year.	Wages paid to all classes.	Men employed above ground.	Men employed below ground.	Boys employed above ground.	Boys employed below ground.	Total employés.
	1	2	3	4	5	6	7	8	9	10	11	12
Total	23	51	2,033,241	1,492,484	$3,306,115	$192,013	$1,854,076	633	2,891	.....	8	3,532
California	3	6	239,027	236,950	663,013	44,013	321,950	93	650	....	8	751
Colorado	8	25	638,233	462,747	1,041,350	114,576	714,714	301	1,133	.....	....	1,434
Montana territory	1	1	1,344	224	800	.....	400	.....	3	.....	.....	3
Oregon	1	2	43,205	43,205	97,810	8,567	68,017	13	63	.....	.....	76
Washington	3	5	161,708	145,015	389,046	21,203	143,754	65	103	.....	.....	168
Wyoming territory	4	6	917,280	589,595	1,080,451	1,072	579,566	149	860	.....	.....	1,009
Utah	3	6	31,544	14,748	33,645	2,582	25,675	12	79	.....	.....	91

Name of state and territory.	Number of miners.	Number of laborers.	Administrative force.	Number of steam engines.	Horse-power of engines.	Value of all machinery.	Value of explosives used census year.	Amount employed as working capital.	Value of plant.	Value of real estate.	Total capital employed and invested.	Acres of coal land.
	13	14	15	16	17	18	19	20	21	22	23	24
Total	2,669	727	136	46	1,495	$287,150	$26,702	$381,445	$1,274,342	$6,858,300	$8,479,573	37,441
California	478	255	18	8	295	77,500	2,367	107,931	535,500	596,000	1,239,431	2,960
Colorado	1,133	227	74	20	749	100,650	11,673	162,550	328,600	5,448,100	5,939,250	23,592
Montana territory	3	.....	.....	.....	.....	.....	.....	250	5,100	7,200	12,550	.....
Oregon	52	21	3	1	60	13,000	1,928	6,500	115,023	105,000	226,523	2,649
Washington territory	103	44	21	4	115	15,500	10,698	15,700	87,721	232,000	335,421	2,600
Wyoming territory	830	159	20	9	228	59,000	36	77,000	179,398	470,000	726,398	1,200
Utah	70	21	.....	4	48	21,500	.....	11,514	23,000	.....	.....	4,440

TABLE No. 42.—*Production of coal in the United States for the year ending June 30, 1880, by coal-fields (tons of 2,000 pounds).*

	Bituminous:		
	Appalachian field		29,842,240
	Western field (Illinois, Indiana, etc.)		8,150,019
e	Michigan field		100,800
	Triassic field (Virginia and North Carolina)		46,246
	Iowa and Kansas field		3,091,540
	All fields west of the 100th meridian		1,492,484
	Total bituminous		42,723,329
	Anthracite:		
	Pennsylvania	28,640,819	
	Rhode Island	6,176	
	Total anthracite		28,646,995
f	Grand total coal production of the United States for the year ending June 30, 1880 (*a*)		71,370,324
	Grand total of hands employed in coal mining		170,676

a 2,817 tons of coal returned from Virginia as anthracite included in above as bituminous.

The production of coal in England was, in 1855, 64,661,401 tons, and in 1877 it was 136,179,968 tons, and in 1880 it was 146,818,122 tons. The English ton, however, is 2,240 pounds. The number of collieries in 1880 was—in England, 3,880, and in the United States, 3,264.

TABLE No. 43.—187 *Ohio coal mines classified on basis of power used.*

Class 1. Mines using no power to supplement manual labor.
Class 2. Mines using the power of animals only.
Class 3. Mines using boiler-power not exceeding 100 horse-power.
Class 4. Mines using boiler-power exceeding 100 horse-power.

Class.	Number of mines in class.	Aggregate maximum yearly capacity, net tons.	Product census year, net tons.	Value of census year's product at mines.	Average yearly product, net tons per mine.	Average value per ton at mine.	Average cost of labor per ton mined.	Average number of days worked by each man.	Average earnings per man, census year.	Average per diem wages earned.	Average product per man per day worked, net tons.	Average horse-power to mine.	Tons mined per horse-power yearly.	Per cent. of value of product paid for labor.	Per cent. of value of product paid for materials.	Per cent. of value of product for profits, including interest, repairs, and royalty.	Average number of hands to mine, all classes of labor, including superintendence.
Total	187	7,775,040	4,702,201	$6,062,258	25,145	$1 30	$0 88	229.4	$230 70	$1 44	1.63	20.4	953	68.45	12.58	18.97	67.1
1	12	231,865	99,875	157,218	832	1 57	93	216.4	267 00	1 23	1.33	.....	.....	59.1	7.47	33.43	29.0
2	88	3,830,000	2,068,000	2,337,000	23,500	1 13	77	267.5	339 00	1 27	1.64	7.2	3,264	68.42	16.57	15.01	53.6
3	78	3,031,000	2,129,421	2,939,625	27,300	1 38	96	223.6	318 00	1 42	1.49	38.2	715	69.34	10.86	19.80	82.2
4	9	682,175	404,908	628,415	44,990	1 55	1 03	228.0	388 00	1 70	1.66	146.0	3,082	66.13	10.95	22.92	119.0

TABLE No. 44.—100 *Indiana coal mines classified on the basis of the power used.*

Class 1. Mines using no power to supplement manual labor.
Class 2. Mines using the power of animals only.
Class 3. Mines using boiler-power not exceeding 100 horse-power.
Class 4. Mines using boiler-power exceeding 100 horse-power.

Class.	Number of mines in class.	Aggregate maximum yearly capacity, net tons.	Product census year, net tons.	Value of census year's product at mines, in dollars.	Average yearly product, net tons per mine.	Average value per ton at mine.	Average cost of labor per ton mined.	Average number of days worked by each man.	Average earnings per man, census year.	Average per diem wages earned.	Average product per man per day worked, net tons.	Average horse-power to mine.	Tons mined per horse-power yearly.	Per cent. of value of product paid for labor.	Per cent. of value of product paid for materials.	Per cent. of value of product for profits, including interest, repairs, and royalty.	Average number of hands to mine, all classes of labor, including superintendence.
Total	100	2,787,710	1,420,324	$2,120,035	14,203	$1 49	$0 97	222	$337 00	$1 52	1.56	28.1	505	65	7.8	27.2	40.9
1	12	42,808	9,807	13,291	817	1 35	87	162	202 00	1 25	1.44	.....	.....	64	5.0	31.0	3.5
2	36	430,082	143,657	214,924	3,991	1 50	84	155	244 00	1 57	1.88	2.4	1,663	56	14.6	29.4	13.7
3	48	2,000,000	1,144,243	1,705,166	23,839	1 49	97	230	346 00	1 50	1.55	44.0	592	65	7.0	28.0	67.0
4	4	314,820	122,617	186,704	30,654	1 52	1 11	246	404 00	1 64	1.48	153.0	200	73	7.0	20.0	84.0

Tables 43 and 44 illustrate, in a general way, the proposition that large mining establishments which employ power and labor-saving machinery, can pay higher wages and give more steady employment to labor than smaller ones. The mines chosen in the two states were typical ones of their classes. The large amount spent for "materials" by Class 2 is, to a great extent, made up of feed, etc., for the animals used.

As a general rule, too, the mines employing capital most liberally can afford to yield to labor a larger share of the value of the product, since their profits depend upon the volume of their business. They also employ more skilled labor. It is believed that these features run through the entire mining industry.

CRETACEOUS COALS AND LIGNITES OF THE NORTHWEST.

BITUMINOUS COALS AND LIGNITES OF THE NORTHWEST. b

By R. Pumpelly.

When the Northern Transcontinental Survey was organized in 1881 the question as to the existence of good steam-coal accessible to the Northern Pacific system of roads was of the first importance for the railroads and for the development of the mining and other industries of the Northwestern Territories.

A vast amount of lignite was known and in places worked and used by the locomotives, but it was recognized as of low heating power, and coal was brought from Pittsburgh to mix with it. True bituminous coal was known c to exist at two or three points, viz, the Chesnut mine, near the Bozeman cañon; on the summit of Mullen's pass, near Helena—both in Montana; and on Puget sound, notably at Wilkinson and Carbonado, on the western flank of the Cascade mountains, in Washington territory. Taking these as clues, the survey, represented by Mr. Eldridge and Mr. J. E. Wolff in Montana and Mr. Willis in Washington territory, discovered and explored, under cover, the extensions of these two fields. In the Bozeman district the outcropping of the two or three seams of bituminous coal was traced and opened along a distance of several miles, while in the Puget Sound region a large number of seams were explored under great difficulties, along a distance of 24 miles south of Wilkeson, through the dense forest of the Cascade mountains. In the broad area drained by the upper Columbia river, which was explored for the purpose by Mr. Bayard T. Putnam, no bituminous coal of any value was found, although beds of lignite attest the coal-bearing character of the Cretaceous. The great development of the bituminous coal north of the 45th parallel d is on the western flank of the Cascade, and on the eastern flank of the Rocky mountains. In my personal exploration of the mountains and adjoining plains between the 45th and 49th parallel I was able to define proximately the position of the line of outcrop the coal for several hundred miles from the Teton river south, via the Dearborn and Sun rivers, around the north end of the Big Belt mountains to the Highwood mountains, and through the Judith country. The result of this exploration and subsequent more careful examination at various points by Mr. Eldridge and his assistants went to show that, with all this immense extent of outcrop and correspondingly great area of coal-seams, it was only occasionally that the coal was at the same time of desirable quality and in workable quantities. The great plains are for hundreds of miles away from the mountains underlaid by lignite seams, often attaining a thickness of 7 and 8 feet, and in places much more, of almost clear lignite. As we approach the mountains the lignite disappears as a rule, and, under the action of some cause, apparently, as our results seem to show, by the e pressure of the enormously thickened overlying cretaceous shales, together with the higher temperature to which they were formerly thereby subjected, aided perhaps by the pressure of plication, the fuel has parted largely with its water and oxygen, and become a true bituminous and quite generally a coking coal. But, together with this change in the chemical character of the coal, there comes also a less desirable change in the structure of the beds. The lignite seams, as at Little Missouri, on Sunday creek, near Miles City and on Bull mountain, are, as a rule, nearly clear fuel, with very little bone or slate partings, and have, consequently, a very low ash percentage. On the other hand, the bituminous seams lie near the mountains, where the much coarser character of the sediment and the great thickening of the formation indicate deposition under less favorable conditions, and we consequently find that, with a less thickness of coal-seams, there is very generally combined a high ash percentage, due to the presence of frequent partings of bone and slate or sandstone. f

The differential sampling carried out by the Northern Transcontinental Survey in many hundreds of explorations made well under cover in the unweathered coal represented several hundred miles of outcrop. The samples taken in a uniformly systematic manner were all analyzed, and taken in connection with the measured cross-sections of the seams, they form a very full exhibit of the character of the seams and of their economic value. As will be seen from Mr. Eldridge's report, the seams not infrequently attain a thickness of 6 to 10 feet, but the cross-sections rarely show more than from 18 inches to 2 feet of clean coal without partings. Although a bed may have an aggregate of from 4 to 6 feet of clean fuel, it will generally contain enough bone or slate partings to render the coal quite dirty. In addition to this comes the fact that as a rule the ash percentage of the *clean* coal, which is very low in some of the Wyoming coals, is quite high here, reaching 6 and 8 per cent., which makes it necessary to mine much cleaner than would otherwise be needful, and also renders it much more difficult to clean by washing. Still, where

a the distance from better coal is so great, a coal having a considerable ash percentage—12 to 16 per cent.—may be profitably used. But at three points very good coking coal in workable quantity was discovered, with a fairly low ash percentage, which last with care in mining could be reduced still lower. One of these was in the Bozeman field on Sec. 24, T. 2, R. 7 E. The extensive explorations of the Bozeman field are described by Mr. Eldridge. Another will be found described in Mr. Wolff's report on the coal of Rock Creek on the Crow reservation. The third is at a point in the Judith basin. Besides these there were found many points where 2 to 2½ feet of clean coal exists free from partings; and at many other points an aggregate of 3 to 4 feet of clean coking coal can be saved by exceptional care in mining and hand-picking.

In the Wilkeson-Nisqually field of Washington territory there is a vastly greater aggregate thickness of coal than in the Montana column, but it also is apt to be injured by partings of "bone". Still Mr. Willis's exploration b of the country south of Wilkeson discovered workable thicknesses of excellent coking coal, and notwithstanding the cheapness of coal imported to the Pacific coast as ballast, it is probable that exceptional care in mining and in hand-picking will in time lay the basis of an extensive mining industry in this field also.

The extensive explorations of the Northern Transcontinental Survey showed that in the great belt formed by Montana, Washington, and northern Idaho the bituminous coals are practically confined to the eastern flanks and outliers of the Rocky mountains and to the western flanks of the Cascades. The few occurrences of bituminous coal found between the two great ranges are of insignificant character. The deposition of the coal-making matter took place on an immense scale in the Puget Sound region, as is shown by the great number of seams of coal.

The bituminous coal-fields of Montana contain but few seams, and these are apt to vary within short distances c in the quality of their fuel. Whether these bituminous coals extend with the Lower Cretaceous beds eastward under the Laramie of the plains is a question more of scientific than of practical interest. The region in which they exist sufficiently near the surface to admit of mining is in the neighborhood of the Rocky mountains and their outliers. This is also the region where fuel may be most needed for metallurgical purposes and for locomotives on the higher grades of the mountains. The time may come when the great thickness of bituminous shales will be of proportionate economic importance for distillation.

While the area of available bituminous coal is limited, the extent of the lignites is very great, probably coextensive with the Upper Laramie. The larger part of the great plains is apparently underlaid by seams of lignite often presenting a thickness of several feet of fuel very low in ash.

These seams are often exposed in the valleys, and over large areas lie at moderate depth from the surface.

d While these lignites are very inferior for railroad use they will be of the greatest value for domestic purposes and for agricultural steam-power, local manufactories, etc., and when the pressure of population shall require it, the extensive and cheaply-mined seams on the Missouri river may furnish the power to pump water for the irrigation of large areas.

Each of the greater subdivisions of the Cretaceous, viz, the Dakota, Colorado, and Laramie, bears coal or lignite in some part of Montana.

Along the eastern and northern flanks of the Belt range in the Judith basin, on Belt creek and Sand coulée and Deep creek, etc., there is only one known coal-bearing horizon, and this is apparently of Dakota age.

In the sections covering thousands of feet of Cretaceous along the lower cañon of the Yellowstone and at the Bozeman coal-field south of Muir coal occurs at only one horizon—about 3,700 feet above the Jurassic and some e distance above fossils considered by Mr. Whitfield to be of Benton or Niobrara age, and yet so low in the great Cretaceous column as to be apparently below the Laramie. As we recede from the mountains on to the plains we find coal in younger horizons in the Lower Laramie. Where the Upper Laramie has been preserved in high ridges of horizontal strata, as at Bull mountain or farther eastward, where it forms the general substructure of the plains, this horizon bears seams of lignite often of imposing thickness and remarkable purity. We have, as yet, no means of knowing whether the Dakota and Colorado groups are also coal-bearing under the great plains.

But nowhere in this field east of the Cordilleras do we find the Cretaceous marked by the enormous deposition of carbonaceous matter that characterizes it on the western side in the Puget Sound region. Here Mr. Willis' test-pits, sunk for the Northern Transcontinental Survey, exposed more than 700 cross-sections of coal-seams in the Wilkeson coal-field alone, representing over 125 separate seams, in a total known thickness of 3,000 feet, underlying f 10,000 feet of barren strata. Although only 17 of these seams were of workable thickness, 3 to 15 feet thick, a vast aggregate of carbonaceous matter is represented.

The occurrence of these Cretaceous coals and lignites over such extensive areas and under such varied physical conditions should lend a promise of light on the obscure causes that have resulted in the lignitic character of the beds in some regions and their bituminous character in others. Little special attention was given to this question. In Washington territory Mr. Willis' explorations showed that the bituminous coals all occupy flexed areas, while the lignites have been but slightly disturbed. This is an observation which was long ago made with reference to the occurrence of anthracite in the highly-flexed folds of the Appalachians and bituminous coals under less disturbed areas. But in Montana coking coals underly the broad plains north and east of the Belt mountains in a practically horizontal position. Indeed, in so far as any present inference can be drawn from our present

data, it would seem to be that height of superincumbent strata, through the consequent pressure and higher temperature, is the most important factor if we exclude possible original differences of the plant matter itself. And this view appears to be held by Mr. Dawson as sufficient to explain the differences in the coals of British Columbia.

Wherever we find the lignites they belong to younger horizons than the bituminous coals. This is the case in the Green River field of Washington territory and on the plains of Dakota and Montana.

The lignites east of the mountains belong mostly in the Upper Laramie. Some beds occur in the Lower Laramie near the top, *i. e.*, in the upper two or three thousand feet—the upper third of the Laramie. The coals north and east of the Belt mountains are of Dakota age, and they have been formerly covered by the vast thickness of the Colorado and Laramie beds that have been since swept away—a thickness of not less than 9,000 feet. The Bozeman coking coals, whether they belong to the Colorado or to the Lower Laramie, dip at a high angle under more than 10,000 feet of younger beds.

Mr. Willis' section (Plate LXXXI) shows that the Green River lignites occupy the upper part of the column, the bituminous lignite coming lower down. The 14,000 feet of Coal Measures in the Wilkeson field show no true lignites, though, as stated farther along, more lignitic beds occur near the top; but we know nothing of the thousands of feet of younger strata that may have been removed.

The capacity of lignites, and to a greater or less degree of other coals also, for absorbing moisture from the air was found to influence materially the economic value of analyses, made in the varying climate of the seaboard, of coals mined in the extremely dry plains of Montana.

For this reason, as is stated on page 775, water was determined in each sample, both after 48 hours drying over sulphuric acid and again after a similar exposure to a water-saturated atmosphere. An inspection of the tables brings into prominence at once the strongly hygroscopic character of the lignites; but it also appears to show that much of the large percentage of water contained in lignites may, in some instances, be simply absorbed moisture. But after making allowances on this score, it will still be found that the samples, after air-drying over sulphuric acid, contain more or less water according as they are more or less lignitic.

It must be borne in mind that samples from the exposed outcrop of a coal seam contain much more water, accompanying an oxidation of the coal. Thus, the writer took two samples across the whole thickness, 12 feet, of the great seam at Elk Garden, West Virginia: A, from the interior of the mine; B, from the weathered outcrop. The following analyses of these samples, made by Dr. Gooch, show the gain in water as well as in volatile combustible compounds and ash, and the deterioration of the coal by oxidation:

	A.	B.
	Per cent.	*Per cent.*
Water	0.19	5.62
Volatile combustible matter	19.98	27.28
Fixed carbon	71.77	54.56
Ash	8.06	12.54
Total	100.00	100.00
Sulphur	1.045	0.809

The following table shows the averages of water contained after drying in the manner indicated, in the samples of the different fields. These fields are here arranged in the order of diminishing average percentages of water in the samples. They are also arranged in the order of increasing value of the fuel. (*a*)

	Averages.	Water after drying 48 hours over sulphuric acid.	Carbon (by combustion analysis).
		Per cent.	*Per cent.*
Lignites of Dakota and eastern Montana (Miles city)		7.3	71.8
Lignites of Bull mountain, Montana	Average of 56 analyses, ranging from 2.6 to 10.4 water	5.6	73.8–76.0
Lignites of Green river, Washington territory	Average of 6 analyses	4.1	
Newcastle (Seattle) lignite	Average of 4 analyses	2.8	74.5–76.8
Bozeman coal	Average of 73 analyses	1.7	79.7–82.5
Green River coal	Average of 9 analyses	1.6	78.9–83.3
Wilkeson coal	Average of 69 analyses	0.78	80.3–93.4

a The quality of the Green River lignites has not yet been tested as compared with those of Bull mountain.

a I have added also a column showing the range of carbon for the samples subjected to combustion analyses for each field. In this column the carbon increases as the water diminishes, and an examination of the table of combustion analyses on page 790 shows that the range of percentage of oxygen and nitrogen increases with the water.

From our present knowledge we can say that the lignites belong in the younger and the bituminous coals in the older horizons of each field. The topographical and stratigraphical evidence goes to show that the bituminous coals have been covered by a thickness of many thousand feet. Thus in the Bozeman field the coal dips, as already stated, under a thickness of not less than 10,000 thousand feet of existing strata. In the Wilkeson field, on Puget sound, Mr. Willis' columnar section (Plate LXXXI) shows the bituminous coals—those which of all known northwestern Cretaceous coals are lowest in water and highest in carbon—to belong over 10,000 feet down in the column **b** yet represented in that field, while the superincumbent covering must have formerly been materially greater. And it is interesting and to the point that the samples from seam CXXIII, represented near the top of the Wilkeson column, contain from 3.98 to 7.04 per cent. of water.

The analyses of the coals under the plains north and east of the Belt mountains show much irregularity in the amount of water. But those samples which were taken from well under cover in the small mines under the plains between the Belt mountains and the Missouri—on Belt creek, Sand coulée, etc.—range below 1 per cent. of water, and it is probable that the higher average of water in the Judith basin samples is due to the oxidation of the outcrops. Thus at Sand coulée the two samples taken from a mine contained 0.56 and 0.47 per cent. of water, while the two from near the surface of the same seam contained 4.02 and 4.84 per cent. The samples from the **c** mines show the coal to be comparable, as regards water, with those of the Wilkeson field. As regards the indications of quality as shown by the proximate and combustion analyses, these almost horizontally-bedded coals range more nearly with those from the Bozeman field.

All the evidence is in favor of the influence of pressure, and of the conditions of temperature, etc., accompanying it, as the chief factor in producing broad distinctions between lignite and bituminous coals; and while within the area investigated by the Northern Transcontinental Survey we have found extensive fields that have been subjected to the combined pressure of superincumbent beds and of plication of the strata, and other wide areas where only pressure of overlying beds exists, the action of plication seems to be of secondary importance as regards this distinction.

While the influence of pressure, with the temperature and other conditions due to the corresponding depth, **d** appears to determine the amount of water which cannot be removed by an absolutely dry atmosphere, it seems possible that the capacity of certain bituminous coals and anthracites for absorbing large amounts of water is often the result of a profound shattering of their texture, brought about by the shearing movement in folds of short radius, and in the crinkling of trough-ends.

Thus the anthracites of the highly-disturbed and pinched beds of the Rhode Island basin have as strong a capacity for absorbing water from the air as the most hygroscopic lignite from Dakota. A sample of this anthracite from the mine at Portsmouth, Rhode Island, after exposure for sixty-one hours over water, contained 16.91 per cent. of water, while after forty-eight hours exposure over sulphuric acid it contained only 0.53 per cent. A sample of Pennsylvania anthracite similarly treated varied less than 2 per cent., and one of Cumberland coal less than 1 per cent.

e Considering the coals and lignites as fuels, and taking into consideration all the means of forming an opinion, they would rank relatively to each other nearly in the order in which they are grouped in the table, the coals of the Wilkeson field being the best, and the eastern lignites, rich in water and oxygen, being very inferior fuel. As compared with the great standard coals of the world, even the Wilkeson coals are at some disadvantage, owing to their higher contents of ash. But in this respect the real difference is undoubtedly much less than appears from a comparison of the analyses; and this for the reason that while, as a rule, published analyses of coals have been made from picked specimens of the fuel, the analyses given in this volume are of samples taken either entirely across the seam or omitting only such portions as would self-evidently be rejected in mining. But while, with several exceptions, these coals are inferior for steam-making to the Cumberland and Clearfield coals, and to the product of the Pittsburgh seam for coke, they will be of inestimable value to the industries of the northwest.

f The following table showing the general character of the Cretaceous beds, including the Laramie, and the position of the seams of coal and lignite in the Wyoming-Utah belt (compiled from King's *U. S. Geological Exploration of the 40th Parallel*), in Montana (Northern Transcontinental Survey), and in southern British Columbia (compiled from Dr. G. M. Dawson's *Report on the Region of the Bow and Belly rivers, Canada Geological Survey*, 1885):

Fortieth Parallel.	Montana.	British Columbia.
LARAMIE.		
Coarse white and reddish sandstones, heavily bedded. Marine and brackish-water fossils. Large development of **coal-seams**. Thickness over 5,000 feet in the Green River Basin.	Upper Laramie.—A rapidly alternating succession of light-gray and grayish-green clays, white argillaceous sandstones, numerous thin **lignite** seams, and 10- to 30-foot benches of yellow massive sandstone containing rounded concretions of brown iron ore; abundant fossil leaves. Thickness, 1,500 feet or more at Bull mountain. Numerous, often large and valuable, seams of **lignite**. Lower Laramie.—A succession of white sandstone and green clay beds near the top, changing below to dark blackish and green clay beds, thin sandstone layers. A few thick sandstones and thin **lignite** seams. Thickness, 7,000 feet.	Porcupine Hills beds.—Sandstones frequently thick-bedded, generally comparatively soft, with intercalated grayish and blackish shales and shaly clays. Fresh water. 2,500 feet. Willow Creek beds.—Soft sandstones, shales, clays, and sandy clays generally with a pronounced reddish or purplish tint. Fresh water. 450 feet. Saint Mary River beds.—Sandstones, shales, and shaly clays in frequent alternations and generally well bedded. Fresh water except near base. Beds of **lignite** or **coal**, especially in lower part. 2,800 feet.
FOX HILLS.		
Coarse white sandstones, heavily bedded. Marine fossils. Thickness, 1,500 feet in the plains; 3,000 to 4,000 feet near the Wasatch mountains. Few **coal** seams; east of the mountains, only 1 seam; farther west, at Cooper creek and Rock creek, several considerable seams of value.	Heavy beds of white and yellow sandstone, forming bold escarpments. Thickness, about 400 feet. No coal observed.	In some parts of the district well-defined massive yellowish sandstone, but inconstant and apparently often represented by a series of brackish-water transition beds between the Laramie and Pierre. 80 feet.
COLORADO.		
Mostly blue and yellow clays and marls, with thin sandstones, fossiliferous. Thickness, 800 to 1,000 feet east of the mountains; greatest thickness in Uintah and Wasatch, 2,000 feet. **Coal** frequent at all horizons in the Wasatch region, but wanting in the east.	Black, bluish, and lighter colored laminated shales, with arenaceous layers. Near the mountains these characteristics are lost in the prevailing uniformity of coarser textual deposits. Thickness not yet separately determinable near the mountains; on the North Moccasin mountain, 1,800 feet. The Bozeman **coals** possibly belong in the Upper or Fort Pierre beds.	Pierre Shales.—Neutral gray or brownish to nearly black shales include a zone of pale soft sandstone in the northeastern part of Bow and Belly River district, and frequent intercalations of harder sandstone near the mountains. Marine. 4-foot bed of **lignitic coal** or **lignite** (11 per cent. water) at summit of Pierre Bow river. Four or more seams at base of Pierre aggregate 7 to 10 inches coal (one seam 2 to 4½ feet) along Saint Mary and Belly rivers. Apparently the most important **coal** horizon. 750 feet. Belly River series.—Composed of an upper or "pale" and lower or "yellowish" portion, and consisting of alternations of sandstones, sandy clays, shales and clays, **coals**. 910 feet. Lower Dark shales.—Gray to nearly black shales, frequently with arenaceous shales. 800 feet.
DAKOTA.		
Sandstones and characteristic conglomerates. Thickness east of Colorado range, 200 to 300 feet. **Coal** in the Uintah mountains.	Chiefly coarse, at times conglomeratic, sandstones. Thickness, 860 feet on Belt creek. Coal flanking Belt mountains is of this age.	

RELATION OF THE COAL OF MONTANA TO THE OLDER ROCKS.

By W. M. Davis.

The following description of the geology of central Montana is based upon observations made during ten a weeks of the summer of 1883, when employed by Mr. Raphael Pumpelly, director of the Northern Transcontinental Survey, to examine the series of rocks below the Cretaceous coal horizon, with special reference to the sequence and characters of the several formations that might aid in the discovery and determination of the coal-fields. The region examined is included between the lower cañon of the Yellowstone on the south, Fort Benton on the north, and Cadotte's pass over the main range on the west, a triangular area of 120 to 140 miles on a side. Of course, only a small part of the district could be studied. Mr. Waldemar Lindgren, assistant geologist, N. T. S., and Mr. F. S. Bunker, volunteer geologist, aided me in the work.

The rock series.—The rocks observed make a conformable series from the Lower Cambrian to the Upper Cretaceous, with a total maximum thickness of thirty to thirty-five thousand feet.

The Archæan was seen only in the neighborhood of Neihart, about the headwaters of Belt creek in the Little b Belt mountains. It there consists of dark, reddish and gray gneiss, with folia generally at steep angles, cut by granitic eruptions that were not found to extend into the overlying bedded rocks. (*a*)

The Paleozoic series begins with a vast series of Lower Cambrian barren slates, at least ten to fifteen thousand feet thick at many points. In the Main range, at Cadotte's pass, red slates and calcareous layers are common; hard sandstones do not appear. In the Big Belt mountains and southward they are generally of a dull color, drab, bluish, greenish, becoming bright red and purple near the top, with calcareous beds in the middle and lower part, and some quartzite layers about the upper third. In the northern part of the Big Belt range, south of the cañon of Smith's river (Deep creek), heavy quartzite with some conglomerates appear. In the Little Belt range, about Neihart (and in the Lower Yellowstone cañon, according to Hayden, report for 1871, p. 53), this great division of c the Paleozoic is seriously reduced and almost absent. A diabasic eruption is found at several places, with the upper members of these old slates.

The slates are capped by a hard sandstone or quartzite, 100 to 150 feet thick, persistent throughout the area examined, and of much service as a recognizable horizon in connection with the equally persistent, thin-bedded, trilobite limestones, 100 to 300 feet thick, that follow after an interval of shales. These limestones are clearly of Potsdam date.

Another interval of soft shales, seldom well exposed, comes next, and above it the great series of mountain limestones begins. This is often rich in fossils of Lower Carboniferous age, but Silurian and Devonian horizons are not yet established. The strata are mostly heavy bedded, with a small share of shales or shaly limestones, and near the top include two or three hundred feet of massive limestones, sometimes brecciated, but seldom showing d distinct stratification, except in its larger forms, as in lines of bluffs or cliffs. The total thickness of the limestones is about 3,500 feet.

In the lower cañon of the Yellowstone the gate of the mountains is cut in a hard, yellow quartzite, 100 feet thick, that promised to serve well as a mark of the change from Paleozoic to Mesozoic formations, but except in the Bridger range it was not found again.

The great Mesozoic series of sandstones and shales, with very rare calcareous beds, that rises above the mountain limestones with a thickness of 15,000, or more, feet, is very imperfectly divisible, as its fossiliferous horizons are few and far between in the neighborhood of the mountains. The identification of red Triassic beds is

a The numerous outcrops of granitic or metamorphic rocks shown conformably beneath the Carboniferous in all the mountain e centers on the map accompanying the geological report of the exploration of the Yellowstone and Missouri rivers by Dr. Hayden, in 1859–'66 (Washington, 1869), are essentially incorrect. The "Red beds" (Triassic) are also greatly exaggerated. According to the geological map of parts of Montana and Wyoming, issued by Dr. Hayden's survey in 1873, with which our results agree satisfactorily, so far as they cover the same ground, Archæan rocks are seen on the western flank of the Bridger range, in the fine Snowy range, east of the Yellowstone, and about the headwaters of the Gallatin and Madison rivers. On the general geological map accompanying Dr. Hayden's twelfth annual report, for 1878 (1883), all the mountainous area north of the Bridger range is extremely incorrect.

a very doubtful; Jurassic fossils occur 600 feet above the limestones; marine Cretaceous fossils are found at a height of 3,200 feet, and Cretaceous coal at 4,400 feet, as determined near the Yellowstone; while conformable sandstones and shales, with very rare and imperfect plant impressions, extend over 10,000 feet higher. Nothing can now be said as to the share of these indeterminate beds that belongs to the several divisions; nor can an upper limit be assigned to the Cretaceous. All the post-Carboniferous strata about the mountains appear to be Mesozoic, with the exception of the late Pliocene or Quaternary lake deposits in the upper valleys, and of certain strata capping the Crazy and Highwood mountains, at great altitude above the coal horizon, which may be early Tertiary, although there is no direct evidence to prove this.

The eruptive rocks, that occur in great variety in certain districts, have been determined and described by Mr. Lindgren; and the brief mention of them in my report is essentially quoted from Appendix B by him.

b The fossils, of which a list is appended, were determined by Professor R. P. Whitfield.

The entire Paleozoic and Mesozoic series is perfectly conformable throughout, although important members—Silurian, Devonian, Coal Measures, and Triassic—are not yet identified, and probably have no significant thickness. The lower strata rest unconformably on the Archæan gneiss; the relatively modern lake-beds unconformably overlie all the other formations. From this, we infer an Archæan land-surface long eroded; a submergence, with more or less active deposition throughout Paleozoic and Mesozoic time; a relatively active mountain growth about the end of the Cretaceous and the beginning of the Tertiary, accompanied and followed by heavy erosion; a second and minor disturbance about the end of the Tertiary, forming lake-basins in the upper valleys, and probably synchronous with the broad elevation that uplifted the plains. Intrusive and eruptive action seems chiefly to have accompanied the two periods of orogenic disturbance, though some was probably of earlier date.

c *Attitude of the coal.*—The horizon of the workable coals near the Muir tunnel, east of Bozeman, is without question lower than the Laramie formation to which the lignitic coals of the Rocky mountain region have generally been referred; for it underlies many thousand feet of strata that, in certain places, contain Cretaceous fossils, and overlies Jurassic fossils by only 3,700 feet. But in all the region close to the mountains the divisions that have elsewhere been made in the Cretaceous series can hardly be recognized; for the rocks are monotonous, of great thickness, and very poor in fossils, so that much more time than our party had must be given before they can be satisfactorily classified. It is otherwise, however, with the rocks below the coal with which we were especially concerned. The series as already described in brief culminates in the great group of mountain-making limestones, the only one of its kind in the region, and always of strong topographic importance where it rises to the surface; the heavy brecciated masses come near the upper limit of the group, and in the low country outside of the limestone **d** ranges, and 4,000 to 5,000 feet (geologically) above them, the first coal horizon may be found. We can, therefore, say at once that the coal belongs north of the Yellowstone lower cañon, and not south of it; at the east foot of the Bridger range, not at the west; that it occupies several basins drained by Sixteen-Mile creek, all inclosed by limestone mountains; that it is quite absent from the Big Belt group, but comes in again in proper order north of the Little Belt. It is a much more difficult matter to determine the attitude of the coal where the Paleozoic rocks are not in sight, as about the Crazy mountains, where only the Cretaceous series or the "coal float" serves as a guide; and this being beyond the work assigned to us, we did not attempt it. After determining where the coal need not be looked for, and where search may be rewarded, there is still much work of closer exploration to be done to discover whether the coal horizon is here coal-bearing or not, and if so, whether the coal is of workable thickness and marketable quality. This was also beyond our province. It is not a little surprising to see that already **e** in a territory so recently occupied as Montana, all of the coal horizons that we determined, and many more out of our field, have been discovered and examined by local prospectors or by members of the Northern Transcontinental Survey.

After this summarized statement of results, the greater part of our report must be taken up with descriptions of the more detailed observations on which they are based.

Measured sections.—Where the structure and outcrops were favorable and our time permitted, the rocks of the older series were measured by telemeter or aneroid barometer, and their fossils were collected with as much care as possible. The results of this work, already presented in summarized form, are now presented in more detail, and illustrated on Fig. 238, under the following headings:

f 1. The Yellowstone section; through the lower cañon and northward. Paleozoic and Mesozoic.
1 A. Section south of Muir. Lower Mesozoic.
2. Across the Bridger range at Flathead pass. Paleozoic and Lower Mesozoic.
3. Wall mountain to Deep creek, southern end of Big Belt range. Paleozoic.
4. Little Belt range, west of Barker. Paleozoic.
5. Little Belt range, north of Barker at head of Otter creek. Paleozoic.
6. Big Belt range, at Benton gulch. Lower Paleozoic.
7. Big Belt range, at Boulder creek. Lower Paleozoic.
8. Cadotte's pass, over the main range. Lower Paleozoic.

These measured sections are supplemented by structural sections of considerably greater length, on Fig. 239.

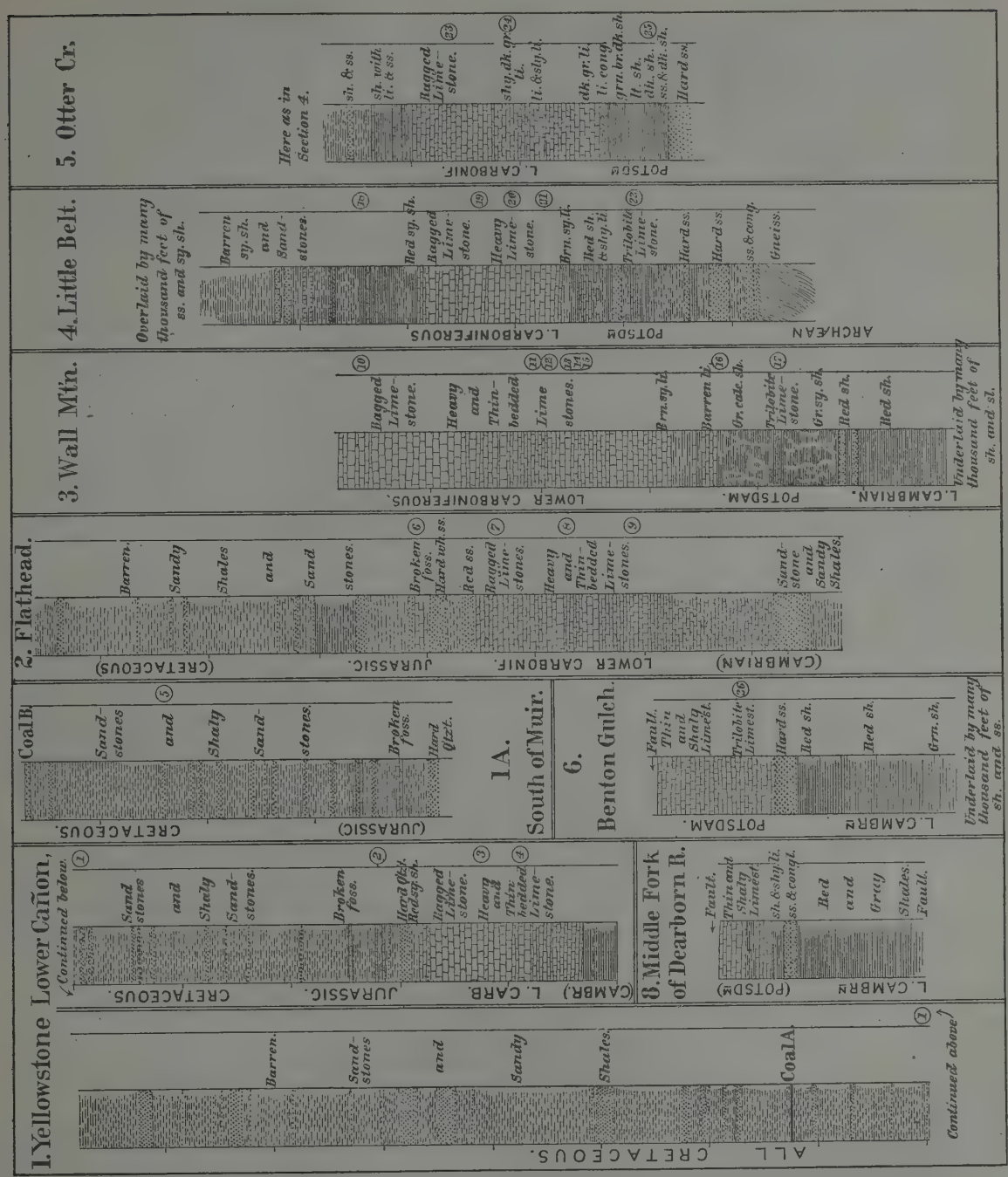

FIG. 238.

Explanatory note.—The descriptions of local sections are numbered to correspond with the structural and columnar sections on Figs. 238 and 239. Localities of fossils are designated by numbers in parentheses in the text and in circles on the plates. The ordinary conventional signs for slates or shales, sandy shales, sandstones, conglomerates and shaly or purer limestones are adopted on the plates, and are sufficiently explained on the columnar sections in abbreviated notes. The abbreviations there used are—brn., brown; calc., calcareous; conq., conglomerate; dk., dark; gr., gray; grn., green; li., limestone; lt., light; qtzt., quartzite; sh., shale; shy., shaly; sl., slate; sly., slaty; ss., sandstone; sy., sandy; vard., variegated; volc., volcanic; wh., white. The scale of the columnar sections is indicated by small marks on the left of the column for every thousand feet; on the structural sections, by small marks on the base-line for every mile; the construction is careful in the former, but in the latter is only approximate. Only the measured sections are given in columnar form; when the outcrops are imperfect the strata are not drawn across to the right of the column. The parts of the structural sections where the measures were made are indicated by a heavy profile line. All formations named on these sections that are not directly proved by our collections of fossils are inclosed in parentheses. No fault-planes were directly observed; they are simply placed where the surface outcrops demand them, and in absence of any evidence of their attitude they are drawn vertical.

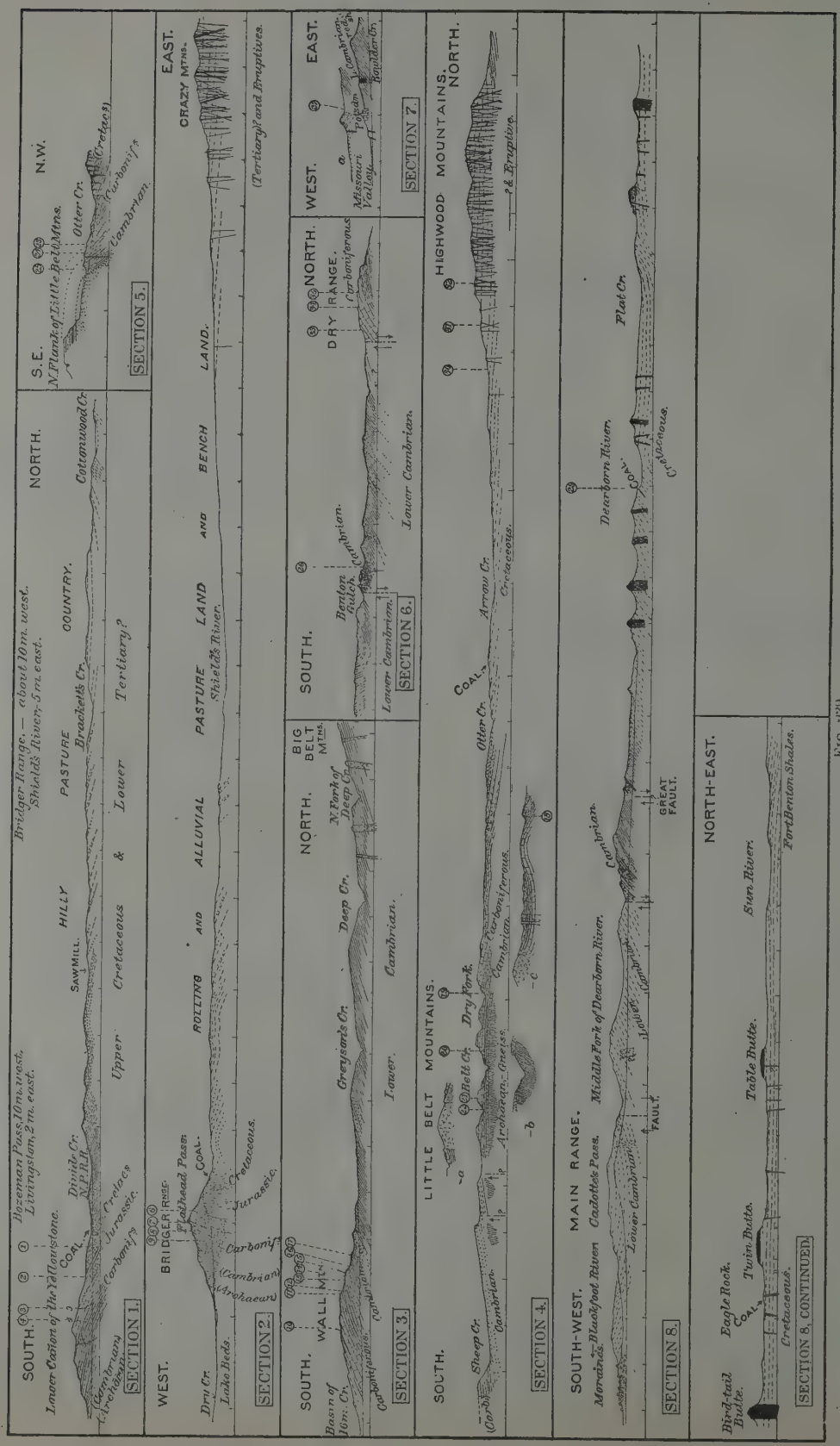
SECTION 1.
SECTION 2.
SECTION 3.
SECTION 4.
SECTION 5.
SECTION 6.
SECTION 7.
SECTION 8.
SECTION 8, CONTINUED.
SOUTH.
NORTH.
WEST.
EAST.
S.E.
N.W.
NORTH-EAST.
SOUTH-WEST.
Bozeman Pass, 10 m. west.
Livingston, 2 m. east.
Bridger Range. — about 10 m. west.
Shields River, 5 m. east.
Lower Cation of the Yellowstone.
Sawmill.
Hilly
Pasture
Country.
Upper
Cretaceous
&
Lower
Tertiary?
Rolling
and
Alluvial
Pasture
Land
and
Bench
Land.
Crazy Mtns.
Big Belt Mtns.
Dry Range.
Highwood Mountains.
Little Belt Mountains.
Main Range.
Wall Mtn.
Bridger Range.
Flathead Pass.
Coal.
Cretaceous.
Jurassic.
Carboniferous.
Cambrian.
Archæan.
Lake Beds.
Tertiary? and Eruptives.
Greyson's Cr.
Deep Cr.
Lower.
Lower Cambrian.
Benton Gulch.
Arrow Cr.
Otter Cr.
Dry Fork.
Belt Cr.
Sheep Cr.
Flat Cr.
Dearborn River.
Great Fault.
Fault.
Eagle Rock.
Twin Butte.
Table Butte.
Sun River.
Fort Benton Shales.
Bird-tail Butte.

FIG. 239.

(1) *The Yellowstone section.*—The measures here were made northward across the strike of a great monoclinal, **a** from the lower part of the heavy limestones, at the upper southern end of the lower cañon, along its western side, across the open country and the coal horizon near Livingston, and beyond the railroad to Fleischman's creek. The base of the limestone series was not found, and the lower measures are inaccurate from local distortion and change of strike; the upper part is more satisfactory. Fossils are rare in nearly all the horizons; enough were found to show the existence of Lower Carboniferous, Jurassic, and Cretaceous horizons, but the barren intervals are so broad that the limits and separate thickness of the several formations can not be given with any approach to accuracy. The 100-foot quartzite that makes the "Gate of the Mountains" may serve as a near indication of the change from the Paleozoic to the Mesozoic. Carboniferous spirifers (see list of fossils 3) occur about 700 feet below it, and heavy limestones are separated from it by only 100 feet of red sandy shales; above it, numerous Jurassic fossils (2) are **b** found within 200 feet. The base of the limestones was observed by Dr. Hayden in the mountains east of the head of the cañon, where gneiss was found at the base of 1,500 or 2,000 feet of Carboniferous, and 100 or 200 feet of Cambrian sandstones, thus showing the essential absence of the lower slates elsewhere found in enormous thickness.(*a*)

North of the cañon the rocks are often covered; where visible they are sandstones, with a few conglomerates, sandy shales, and shales, often showing cross-bedding. A few imperfect Cretaceous fossils (1) were found 3,200 feet over the limestones. The important coal-bed explored by Mr. Eldridge, N. T. S., is 1,200 feet higher, and above this we measured 6,500 feet of barren sandstones and sandy shales to the southern margin of Fleshman's creek synclinal, and estimated at least 5,000 feet more, all in perfect conformity across the rolling country northward to the synclinal hills beyond Brackett's creek. There is no direct evidence as to the age of these upper **c** rocks. They yielded only very rare and indeterminate plant remains.

(1 A) *Section south of Muir.*—While getting together my outfit at Mr. Eldridge's camp, 2 miles south of Muir (where the railroad tunnels under Bozeman pass), I employed some spare time in measuring the tilted strata, here well exposed from the coal horizons down to the quartzite that rises on the back of the limestones in the Bozeman mountains. The result is sufficiently shown in the columnar section. Coal B of this section has been determined by Mr. Eldridge to lie 10 to 15 feet under Coal A of section 1. It agrees satisfactorily with the section on the Yellowstone, from which it was distant 12 miles to the west. The fault shown in this district on Dr. Hayden's geological map of parts of Montana and Wyoming should be replaced by an anticlinal fold about an axis plunging steep to the northwest.

(2) *Section across the Bridger range at Flathead pass.*—The heavy Carboniferous limestones, which form the **d** crest of the Bridger range, are here overthrown so as to dip 60° to 70° to the west; the pass is apparently determined by a small transverse fault, of which the limestones show indication by displacement. Our measures extended through 3,500 feet of sandy Mesozoic strata on the eastern slope, and through 3,000 feet of Paleozoic limestones and sandstones on the west. Imperfect Jurassic fossils (6) were found 500 feet from the heavy brecciated limestones; no Cretaceous fossils were discovered, but, judging from section 1, the coal horizon must run close along the eastern foot of the Bridger range. Heavy timber concealed many outcrops on the western slope, and the narrowness and numerous turns of the ravine leading down from the pass, as well as our limited time, prevented our securing accurate measures or a full series of fossils from the lower rocks. The limestones of the crest-line are the uppermost brecciated members of the series; Lower Carboniferous fossils were found 300, 900, and 1,550 feet below the uppermost limestone. Calcareous beds continue 1,000 feet lower down, and it was probably in some of these that **e** Dr. Hayden's party found Cambrian fossils in 1872.(*b*) The limestones are succeeded by 1,000 or more feet of sandstones and sandy shales, strongly overturned, and generally buried under *détritus* in the foot-hills. Southward of the pass, on the western flank, Dr. Hayden records the occurrence of Archæan rocks. The valley of Dry creek, which flows south into the East Gallatin, is occupied by an arm of the broad lake-beds of the Bozeman-Gallatin basin.

The part of our structural section east of Shields' river is from notes by Mr. Wolff, N. T. S. The Crazy mountains are thus shown to be homologous with the Highwoods of section 4.(*c*)

(3) *Wall mountain to Deep creek, southern end of Big Belt range.*—The whole Paleozoic series, with the exception of its lowest part, is here exposed in unbroken sequence, giving one of our best sections. It shows a remarkable thickness of bedded rocks, begining with the estimated 12,000 feet of Lower Cambrian slates, extending upward **f** through 4,500 feet of measured sandstones, shales, and heavy limestones, and culminating in Mesozoic rocks of

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a Geological Survey of Territories, 1871, p. 53; 1872, p. 30, 30. See also Dr. Peale's account of this cañon, 1872, p. 171, and of the limestones in Rocky cañon, now followed by the railroad west of Muir tunnel, 1872, p. 109.

b See Report for 1872, pp. 74, 75, 84, 171, 172; the range is here called the Gallatin.

c Mr. J. E. Wolff, assistant geologist, N. T. S., spent the past summer (1883) in studying the coal outcrops around the Crazy mountains, and kindly allows me to quote the following general description of that outlying range: "The mountains consist chiefly of barren sandstones, slates, and shales, lying above the coal, and hence considered Upper Cretaceous and Lower Tertiary; they generally dip with small angle into the mountains, but about the northern end are more disturbed. At once, on passing from the surrounding open bench land to the mountain slopes, one meets with eruptive rocks in great profusion; the rocks are literally honeycombed with large and small dikes running in all directions. In places one can see grand displays of dikes in every attitude, cutting a thousand or two feet of horizontal sandstones and slates from bottom to top. The eruptives occur in great variety, and at least three periods of eruption can be recognized by intersections." This shows a close similarity between the Crazy and the Highwood mountains.

a 2,000 or 3,000 feet estimated thickness. The series is well exhibited in numerous and characteristic outcrops, and is perfectly conformable throughout. The oldest slates, cut by broad granitic dikes, form Bald Peak and its neighbors of the Big Belt range east of Townsend; the beds here are chiefly fine gray, bluish, or greenish slates, well indurated. The middle members of the series are gray or bluish, and form high grassy hills with patches of timber south of Deep creek. Near the upper third a number of hard sandstone beds appear. The upper members become shaly, and at last, after about 1,000 feet of dark purplish beds, our telemeter measures began on an equal thickness of red slaty shales, which bring us to the hard sandstone and fine conglomerate ridge encircling the northern flank of Wall mountain. From this point upward there is the normal fossiliferous series, but with unusual thickness. The Potsdam seems to have a greater thickness than determined elsewhere from the fossils (16) found b 500 feet above the ordinary trilobite limestone (17), but the former may belong higher in the series. It is to be hoped that a more persistent search would discover fossils in the next succeeding limestones, for 1,300 feet higher our specimens (15) are pronounced by Professor Whitfield to have a decidedly Devonian aspect. The succeeding 2,000 feet of limestones, mostly heavy bedded and brecciated near the top, are proved to be Lower Carboniferous. These limestones outcrop in successive buttresses or walls that encircle the northern end of the mountain, and they are cut through by a small stream, dry when we followed its channel, that leads into Sixteen-Mile creek; thus fine exposures of the rocks are presented. No more interesting field was found during the summer's expedition, and if studied in connection with the ranges running southwest to the upper cañon of the Missouri below Gallatin City, and southeast to the Bridger range, and thence toward Bozeman, it would form a most instructive region for areal c and section work.

(4) *Little Belt mountains, west of Barker.*—This section is as valuable as the preceding, with which it presents an interesting contrast. It was measured at several bluff outcrops of nearly horizontal strata in different parts of the series, as shown by the heavy profile line on structural section 4, on a line running nearly north and south, crossing Belt creek about 8 miles below Neihart and the Dry fork about 6 miles below Barker. The series includes the Archæan foundation of gneiss, overlaid by heavy sandstones and sandy shales, with a little white quartz conglomerate at the base, and with the Potsdam trilobites (22) that elsewhere overlie 10,000 or 15,000 of stratified deposits, here occurring at only 1,100 feet from the lowest bedded rock; these are soon succeeded by the even-bedded Lower Carboniferous limestones, rich in fossils (21, 20, 19), by the heavy, ragged limestones, and by shaly beds, with calcareous layers containing Lower Carboniferous fossils (18) at a level that we had before thought to be Mesozoic; these last were found on the northern side of a fine limestone dome that lies outside of the mountain d flanks north of Barker (section 4, —c). The higher beds continue in a flattening monoclinal of barren sandstones and shales, with poor outcrops, to the Cretaceous coal of Otter creek, and beyond with great thickness into the Highwood mountains; the fossils (30) found on the southern flanks of the latter are Cretaceous, but higher in the mass they (31, 32) are doubtful, although pointing to the same formation. Interesting eruptive masses of hornblende andesite or dacite, as determined by Mr. Lindgren, break through the Paleozoic strata of the Little Belt mountains (section 4, —a, —c), and basaltic and trachytic dikes in large variety intersect even the topmost beds of the Highwoods in all directions, which are thus shown to be strikingly similar to the Crazy mountains, but we saw nothing of the continuous volcanic area, or of the northward extension of the Carboniferous, shown on the general geological map of the area explored and mapped by Dr. Hayden.

e (5) *Little Belt mountains, Otter creek, 5 miles northeast of Barker.*—This section was measured southward up a small branch of Otter creek, about 2 miles east of the bridle trail leading out of the mountains from Barker. It was peculiar in yielding a series notably unlike that of section 4, only about 10 miles distant to the west. The ragged limestones are persistent, but the richly fossiliferous limestones of Belt creek and its Dry fork have here almost disappeared, and it was with difficulty that enough fossils (23, 24) were found for the identification of the Lower Carboniferous. Beneath 1,000 feet of these strata there came 850 feet of firm and slaty limestones, in which no identifiable fossils were found, and still lower 500 feet of varied slaty shales, in the lower part of which Potsdam trilobites (25) were found of a genus (*Dikellocephalus*) different from that commonly occurring elsewhere in the Potsdam limestones (*Conocephalites*).

(6) *Northward from Benton gulch, northeast of Big Belt range.*—This section was measured northward from the stage-road between Diamond City and Fort Logan, a mile before it enters the open country of Smith's river (Deep f creek), about 5 miles northwest of Fort Logan. We here again found a great development of the Lower Cambrian series below the Potsdam horizon, but unlike that of sections 3 and 8 in holding a number of heavy indurated sandstones with some conglomeratic layers. This would seem to indicate shallows in the old Cambrian sea on approaching the long-existing Archæan island in section 4. The top of the section, cut off by a well-proved fault, consists of limestones and shaly limestones; Potsdam trilobites (26) were found in the lower members of this group. The hard sandstone and the red shales came a little distance below these, as in Wall mountain, section 3, then a monoclinal series at least 10,000 feet in thickness, unless repeated by faults of which we had no sufficient evidence; the lowest layers were cut off by a fault that brought down the ragged Carboniferous limestones, with a throw consequently to be estimated at 14,000 or 15,000 feet. The more even-bedded Lower Carboniferous limestones then rise to form the Dry range, a subordinate, flat, monoclinal ridge, with a good variety of fossils (33, 34, 35); they seemed to be underlaid to the north by rocks of the lower series again, but we had no time to examine them.

(7) *Boulder creek, Big Belt range.*—The old Cambrian slates were measured here below the Potsdam trilobite a limestones where Boulder creek flows out on the open lands of the upper Missouri, up the stream to Diamond City. The measures are of but moderate accuracy, as the strata are rather unevenly tilted at several points, besides being intersected by granitic and other dikes near the mountains. The series consists of barren red and purplish shaly slates near the top, changing to gray and bluish lower down, and with some hard sandstones near the bottom, the total thickness measured being about 10,000 feet, and this without entering the heavily-timbered higher points of the mountains. The upper part is drawn in structural section 7, to show the attitude of the limestones that rise in a low ridge north of the creek, and their problematic relation to a ledge of hard quartzite on the same strike, half a mile north. The undisturbed attitude of these two layers over the red shaly slates is shown in section 3. They seem here to be affected by local fractures. Closely-adjoining limestones yielded fossils from two horizons, b Potsdam and Lower Carboniferous, and from this, as well as from structural evidence, we have supposed a fault or a torn fold to follow the western foot of the Big Belt range about this locality.

(8) *Section across the main range at Cadotte's pass.*—This section was disappointing in giving no good determinate series of rocks for measurement. A vast thickness of Lower Cambrian slates and shales was exposed in the synclinal axis of the mountains, and repeated by strike faults in the eastern foot-hills, but neither the Archæan base nor the ordinary Potsdam limestones could be found in proper sequence with them. The Archæan rocks do not appear in this part of the range, and although limestones that undoubtedly belong to the Potsdam were found on the Middle fork of the Dearborn river, they yielded us no fossils, and must be regarded as cut off from the main mass of slates by a fault. The most probable sequence of the older slaty rocks that we could put together was c obtained on the Upper Blackfoot river, from the moraines (marked on the section) to the summits about the pass; it is as follows, from below upward: Dark slates with a few sandstones, 900 feet; red slates and slaty shales, 1,100; red, gray, and greenish-gray slates and slaty shales, 300; red slates, 300; gray slates, 900; gray slates with some red beds, 300; gray slates with scattered Calcareous beds, 1,200; total, 5,000 feet. The attitude of this mass in the Cambrian series is not determined, but it is very probably in the middle or lower part; its red beds do not seem to correspond with those near the top of the series at Wall mountain, Boulder creek, or Benton gulch. No fossils were found, although many beds were carefully searched over.

The upper part of the series, between these older slates and the great fault of ten or more thousand feet, that brings down the presumably Mesozoic strata of the lower country, is shown on columnar section 8 in sufficient detail without further description. d

The Mesozoic rocks farther eastward were very imperfectly exposed, and yielded no fossils to our hasty examination, except close to the coal of Dearborn river, where a few imperfect Cretaceous shells were found (29). The dark shales east of Sun river were supposed to be of the Fort Benton group, from their relation to the outcrops on the Missouri river.

Mullen pass, head of Little Blackfoot river. Many eruptives, strongly-marked alteration of certain beds, and the appearance of concealed faulting prevented our determining satisfactorily the relations of the rocks in this district. The tunnel through the pass is cut through a ridge consisting of members of the Lower Carboniferous limestone, dipping west, broken by intrusive granites. In the valley west of the pass, coal has been found, but its relations to the adjoining rocks could nowhere be discovered. A high ridge a little farther west, through which the Little Blackfoot has cut its way westward, is made of indurated slates and sandstones on the east slope, with e the higher parts and western slopes of Lower Carboniferous limestone in typical appearance, overlaid on the west by Mesozoic strata. In the cross valley, Jurassic rocks were found 2 miles above Logan's ranch, but their relations to the Carboniferous were not fully made out.

East of the pass, the limestones are altered for some distance from the granites. Going farther toward Helena, a considerable breadth of barren slates, shales, and sandstones are found; they are probably Cambrian, but we could give no time to their examination.

MOUNTAIN STRUCTURE IN CENTRAL MONTANA.

The reports of Messrs. Hayden and King show that in Colorado and southern Wyoming the Front range of the Rocky mountains rises abruptly from the plains, so that one passes in a breadth of a few miles from the f horizontal strata of the endless open country on the east, across the sharply-upturned Mesozoic and Paleozoic strata of the foot-hills to the granitic rocks of the mountains. There is no distinct foreshadowing of this great change at a little distance out from the range, and intrusive rocks are very rarely found in the younger strata. This simplicity is lost in going north, and in Montana we find a much more varied and complicated structure in the several ranges examined between Bozeman and Fort Benton, from latitude 45° 50′ to 47° 50′. In the first place, mesas or heavy dike-ridges of eruptive rocks are not infrequently seen 20 to 40 miles away from the mountains, so that the change from plain to mountainous country is generally gradual, not abrupt; in two cases these outlying eruptives have become centers of short groups, namely, the Highwood and the Crazy mountains, of considerable height, without the aid of Paleozoic or Lower Mesozoic rocks. In the next place, there are upheavals of Paleozoic

a rocks branching off of, or altogether separated from, the main range; the Black hills make the southernmost, and perhaps the largest, as well as certainly the best studied example of this type; the Big Horn range (*a*) probably belongs here as well. Farther north, closer to the district we have seen, the Little Belt range branches to the east-southeast or southeast of the more continuous mountain front, and other outliers, presumably of a similar nature, exist farther north.

Finally, the Front range here loses the pre-eminence, the directness and the continuity that characterize it farther south, and hence this name, so appropriate in Colorado, is not used in Montana; it might, however, be applied with more technical meaning to the first long, almost continuous exposure of the Paleozoic rocks found westward from the plains, especially as in northern Montana and in the adjacent British territory it seems to b regain the simple and dominant form that distinguishes it in Colorado. The term is, however, unsatisfactory, for the mountains that certainly deserve the name of Front range, if the name has any application at all, are sometimes so little elevated that the Mesozoic rocks cross over them, as, for example, at the south end of the Bridger range, (*b*) and are not unfrequently equalled in height by outlying mountains farther to the east.

Throughout this central region of Montana we find scenery that is often fine and pleasing, but, as a rule, of a mildly mountainous type. Sharp and rugged peaks are generally absent, and the views from the valleys, passes and summits nowhere attain the grandeur found farther south or north. (*c*) Permanent snow patches are scarce and small; even the old glaciers had here a small development.

The descriptions of mountain structure that follow will show that the entire conformable series of Paleozoic c and Mesozoic strata were uplifted during later Cretaceous and earlier Tertiary time. Throughout and after this time of mountain growth vast masses of the older rocks were worn away from the new land-surfaces and deposited elsewhere, chiefly as early and middle Tertiary strata; some of the earlier erosion may have supplied material for later Cretaceous beds before the uplifts had become strongly marked. It is on this account that Eocene and Miocene formations are so generally absent here. But near the end of Tertiary time another movement, or a late phase of the original mountain uplift, disturbed the then established drainage lines by irregular tilting, and so formed a number of orographic lake-basins generally back of the Front range. These were filled to considerable depths with fine argillaceous and marly sediments of presumably Quaternary date, which unconformably overlie the eroded rocks of various earlier formations, thus proving their existence as dry land during the greater part of the Tertiary, as above mentioned. It is these old lake-beds that form the open, dry bench-lands across broad valleys among the various ranges of the Rocky mountains of Montana; and it is noticeable that every one of these areas d is drained by a stream flowing through a comparatively narrow cañon, the recent work of the lake overflow in cutting down the lowest part of the old barrier. Examples are seen in Paradise valley, above the lower cañon of the Yellowstone; (*d*) the Bozeman-Gallatin-Madison plain, above the upper cañon of the Missouri; the Townsend-Radersburg valley, above the lower cañon of the same river; open valleys, above the lower and middle cañons of the Madison; (*d*) a smaller example on the Little Blackfoot, above Lincoln; and, finally, the valley of Smith's river, above its cañon in the Little Belt mountains, this being the only example of a post-Tertiary lake that we discovered outside of the Front range. Since the filling of the basins and the cutting down of the outlets together succeeded in destroying the lakes, their deposits have been exposed to denudation proportionate to the deepening of the cañons below their upper surface; thus the streams issuing from the mountains have, unfortunately for the ranchmen, e sunk their channels 30 to 100 or more feet below the bench-land. If these valleys had been settled a few thousand years ago, irrigation of the upper fields would not have been so difficult as it has now become. During the later stages of the lake period, and perhaps continuously down to the present time, a surface-coating or "wash" of coarse material has been spread over the bench-land, from the adjoining mountain slopes, often making it too stony for cultivation, even if irrigating streams could be led upon it. This "wash" is, so far as we could determine, always of local origin, and, in spite of the considerable size and angular form of some of the stones, it seems chiefly of subaerial origin. Ice action was not shown to have had any share in its distribution. Below the lower cañon of the Yellowstone, in the neighborhood of Livingston, where there was no reason to think a recent lake had existed, the coarse wash seems to lie directly on the eroded Mesozoic rocks, smoothing them off to an even slope, without the intervention of lake-beds. Several interesting problems arose in connection with this, and in relation to the old lakes among the mountains, but we had no time to follow them to their solution.

f In spite of their synchronous growth, the mountain ranges within our field of observation show a remarkable variety and irregularity of structure. The Bridger range is a steep or overthrown monoclinal, with the heavy limestones for its crest and a strong fault or torn fold bringing up the oldest rocks along its western base. The Big Belt mountains are composed chiefly of an oval anticlinal of old slates, with steep dips and granitic intrusions.

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a Hayden (Report for 1868, p. 70 of reprint of 1873) describes the Big Horn range as containing the same series of granitoid and stratified rocks found in the Black hills, but connected with Wind river section of the main range by a very rugged area of eruptives.

b Hayden, 1872, p. 30.

c The Crazy mountains, an isolated outlying range of Mesozoic strata (see p. 701), seemed to offer finer scenery than the other ranges of central Montana, but we saw them only from a distance.

d Compare Dr. Hayden's Report for 1872, p. 33, and geological map of Montana and Wyoming territories, above headwaters of Madison, Gallatin, and Yellowstone rivers (187–).

The main range, at Cadotte's pass, (*a*) consists of a flat synclinal of old slates, with heavy strike-faults on either a side. The Little Belt mountains, in the Barker district, show a broad, flat anticlinal or plateau structure, with exposures of the Archæan where strongly eroded about Neihart, but with a continuous cover of limestones farther west. The Highwoods and the Crazy range have already been mentioned as consisting of remnants of late Cretaceous strata locally indurated by numerous dikes. Hence, whether we consider the Front range alone or all the ranges together, there is small opportunity to generalize on their structure. They may now be described more in detail.

THE BRIDGER RANGE.

Structure.—This range presents a comparatively simple topographic form, as it consists essentially of a steep b north and south monoclinal of Paleozoic rocks in which the heavy limestones form the crest-line, while the older series even down to the Archæan appear on the west toward the East Gallatin plain, and the newer formations outcrop on the east toward Shield's river.(*b*) The range begins at Bridger pass, near Bozeman, where the older rocks rise from beneath the Mesozoic, (*c*) and extends with remarkable directness 20 miles to the north, when it ends very much as it began. The several lines of elevation farther north, about Sixteen-Mile creek, are of irregular structure and belong between the Big Belt and the Bridger ranges. Dry creek, a branch of the East Gallatin draining the northern half of the range on the western side, follows a broad valley between the Archæan and low Paleozoic rocks of the Bridger on the east and hills of Paleozoic and Mesozoic strata on the west. These latter outcrops are the northerly continuation of the beds exposed in the excellent section along the Gallatin river a little above Gallatin c city, described by Drs. Hayden and Peale. (*d*) Their connection with the Bridger range is obscure. Dr. Hayden says there are several local anticlinals and synclinals in the interval between the Flathead pass and the Missouri, and to these we are inclined to add a heavy fault as well, for it is difficult to explain the valley of Dry creek as an anticlinal alone. There is no western dipping monoclinal that corresponds in height to the eastern or Bridger half of a simple arch; and at the northern end of the range, where the heavy limestones lose their steep dip and roll down to a normal altitude as they descend northward under the Mesozoic formations, the hard, ridge making rocks do not continue westward across the basin of Dry creek, but end abruptly at its eastern margin. Far south the fault may be absent.

At Flathead pass, and probably at other points toward Bozeman, the rocks of the mountain crest are overthrown past the vertical so as to dip 70° or even only 60° to the west, and here the Mesozoic strata of the eastern slope d apparently underlie the Carboniferous of the ridge-line. The eastern foot-hills are separated from the range by a comparatively low valley drained by Bridger creek at the south into the East Gallatin; farther north by Brackett's and Cottonwood creeks that flow eastward into Shield's river; and finally by a branch of Sixteen-Mile creek. This long strike-valley follows beds that cannot be far from the coal horizon, unless unseen folding or faulting complicates the relation between the upper and lower rocks; and further, it marks in general the line between the steeply-inclined old strata of the range and the less tilted newer strata of the foot-hills and lower country. No fossils were found to show the age of these hills, but they are probably of the same horizon as the synclinal of Fleischman's creek, north of the railroad, between Livingston and the Muir tunnel, described in the Yellowstone section. At that point they are all evidently conformable with the known Cretaceous below; but here Dr. Peale, who considers them of Tertiary age, has described them as unconformably overlying the Bridger uplift. (*e*) We could find no e sufficient proof of this. There is very evidently, as our section shows, a marked change of dip between the range and the foot-hills, and of strike as well at many points; but all this change could very well result from the great crushing by which the overturned monoclinal was produced. At the northern end of the range, the Mesozoic strata follow the Carboniferous in simple succesion. We therefore conclude that the Bridger uplift was contemporaneous with that of the other ranges in central Montana, somewhere in the long unrepresented interval after represented epochs of the Cretaceous age.

THE BIG BELT RANGE.

Structure.—The Big Belt range, from Sixteen-Mile creek northward beyond Diamond City, is essentially a long, elliptical anticlinal, measuring 30 by 20 miles, composed of a great mass of low Paleozoic slates, cut by granitic dikes, and reaching elevations of 9,000 feet; thus rising 300 or 400 feet above the timber-line, and retaining some f small patches of snow in a few of its upper ravines through the summer. Its distortions are of a very broad pattern, and folds of small curvature were rarely found within its limits; in the finer layers an incipient cleavage of steep dip is very common. The old slates, dipping irregularly near the middle of the arch, and with steep outward dips on the east and west sides, occupy nearly all the mountain area; the granitic intrusives cover but a small share of the surface, near the center, and the old quartzite and the great limestones are not to be found before reaching the

a And for a long distance northward, according to observations by Mr. Pumpelly.

b Compare Dr. Hayden's Report for 1871, pp. 45, 46; 1872, pp. 29, 30, 74, 75, 84, 171, 172. The statement concerning the Archæan is taken from Report for 1872, p. 75.

c Id., 1872, p. 30.

d Report for 1872, pp. 72, 172.

e Hayden's Report, 1872.

a margin of the mountains. The eastern flanks were mostly beyond the route of our party, but where visited or when seen from a distance were safely recognized as the old slates dipping away from the central axis to southeast or northeast, and presumably retaining a similar or easterly dip all along this slope. The western flanks, from Boulder creek south to Deep creek, seem to be of similar structure, with opposite dip, but are broadly covered on the lower slopes by a smooth "wash" of recent date; the few ridges that rise through this even surface being outcrops of the hard sandstones that occur in the slates about 4,000 feet below their top; the same hard layers are well shown in the cañon of Deep creek, just above Mr. Carpenter's ranch, about —— miles east of the Missouri.

In going southward from the mountains one may follow the slate anticlinal past the cañons of Deep and Greyson creeks, and well beyond toward Sixteen-Mile creek, where the dip of the anticlinal axis finally carries b the slates underground. This part of the middle line is not marked by notable elevations, and Deep and Greyson creeks heading to the east of it flow westward across it. The hills of slate are, as a rule, bare of forest growth, and especially in the upper part of the series show their structure, when viewed from a little distance, in grass lines following the belts of more fertile strata, while the ravines give ample outcrops for detailed study. Eastward of this district a synclinal is formed by the slates rising with westerly dip from their eastern plunge, and thus they extend beyond the upper basin of the North fork of Sixteen-Mile creek, in barren, rolling hills that are crossed by a road leading to White Sulphur Springs. This synclinal holds summits that attain a commanding height, and, on following its axis as it descends gently to the south, we are brought to Wall mountain, east of the cañon of a dry fork of Sixteen Mile creek, a wonderfully fine series of curved, rampart-like outcrops of the old quartzite and the c great limestones; it may be regarded as resembling the prow of a flat-bottomed boat, and is more like Pennsylvanian structure and topography than anything else seen in Montana. Going still farther south, this opens out into the Lower Mesozoic basin of Sixteen-Mile creek, and its eastern rocks are cut by the cañons of this creek and its North fork before they rise into the limestone range that runs to the Missouri, just north of Gallatin City.

Crossing to the western side of the old slate anticlinal, the lower quartzite and some of the lower limestones, with southwestern dip, cap a ridge to the south of Greyson creek; they continue with narrowing area across Greyson creek, near which the quartzite makes a pronounced ridge, and beyond to Deep creek, but thereafter are hidden under the bench-land—if continuing farther north—until they reappear north of Boulder creek, 16 miles farther on. The doubt about their continuity across this interval comes from the absence of intermediate ridges and outcrops through the bench surface, and even of ledges in the stream channels that are here frequently sunk 70 or 80 feet d below it; and still further from the appearance, at several points along the ridge from Greyson to Deep creek, of an eastern dip implying a change from the anticlinal of the mountains to a synclinal or torn fold having its axis along this line. If this were the case the absence of the old quartzite would be the simple result of erosion to a little lower level than where it was turned up or broken off.

The reappearance of the quartzite and limestone north of Boulder creek repeats many of the conditions of their disappearance south of Deep creek, with the addition of rather more marked irregularity of position, suggesting that the supposed synclinal has here especially been torn into a fault; and, indeed, so it may have been for the greater part of its length. The narrow wedge of old quartzite and trilobite limestones between the high hills of red slates on the east and the open, low bench-land on the west, widens to the north, where the appearance of the ridges in the distance suggested the presence of a large part of the great limestone series. Going up the e unsymmetrical valley of Boulder creek, we descend obliquely through about a mile's thickness of the slates, which dip to the northwest with moderate regularity before the cañon is reached at the mouth of Confederate gulch. Turning here to the south, nearly as much more slate is passed through before coming to an anticlinal, beyond which the strata dip for some distance rather irregularly or obliquely toward the mountains, instead of away from them, as elsewhere. Dikes become rather common beyond the change of dip. If, instead of ascending the cañon of Boulder creek, one follows the stage road past Diamond City and over the divide to Benton gulch, which leads eastward down toward Fort Logan, the shaly slates are found dipping northward, and when near the low country of Smith's river (Deep creek) they have turned still farther, so as to dip northeast. The occurrence of a well-proved fault of strong throw near the mouth of Benton gulch suggests the probability of others between this valley and the mountain center by which the otherwise vast thickness of the slates here may be reduced at least within the f not very moderate measure of three miles. The fault alluded to runs nearly along the strike of the rocks, on the northern side of Benton gulch, and brings the trilobite limestones down opposite the calcareous beds of the old slates—a throw of perhaps 8,000 feet. The beds are flexed upward on either side of the fracture, but most distinctly on the south, where a synclinal is produced, 2 or 3 miles wide, near the mouth of the gulch, narrowing westward. On the northern side, the limestones are upturned for only a small distance, but the appearance of a torn synclinal is given by a great mass of the old quartzite, which stands nearly vertical, and which must mark very closely the position of the fault-plane. Farther north there is an apparently unbroken monoclinal, with moderate, constant dips to the south for about 5 miles, the greater part of which consists of the equivalents of the old slates, here much sandier than usual. The series is very well exposed, and unless faulted gives a trustworthy measure of over 10,000 feet of rocks below the old quartzite. On the north it is cut off by a fault of enormous throw at the foot of the Dry range, which brings the heavy, ragged limestones of the Upper Carboniferous down opposite these old shales. This displacement must be in the neighborhood of 15,000 feet. There is a very striking revelation of structure in the

grass-lines already mentioned as characterizing the upper slates on the northern slope of the valley next beyond **a** the quartzite; broad and narrow bands of gray and green can be traced along the surface for half a mile at a stretch, and show a surprising number of cross and oblique faults of small throw. In this increasingly persistent easterly strike we have the transition from the structure of the Big Belt to that of the Little Belt mountains; and although the latter is represented on the maps as only on the east of Smith's river, while the former is marked as extending northward to the Missouri, it seems advisable to transfer the description of the Dry range, which comes next beyond the monoclinal of old slates and sandstones, to the next section.

Igneous rocks.—In the central and higher parts of the Big Belt anticlinal of old slates, dikes and irregular masses, chiefly of intrusive granitic rocks, are very common. They seem to have had much influence in hardening the rocks about them, as the fragments of argillaceous, calcareous, siliceous slates on the upper slopes are of firm, **b** almost crystalline, texture, and give a sharp, ringing sound when struck. They may also have aided in dislocating the strata, as irregularity of dip increases toward the center of the mountains. Some of the intrusives of the southern part of the range, within the drainage of Deep creek, are distinguished by quartz-crystals in double pyramids, while the large granite boulders brought out from the northern massive, by the old glacier of Boulder creek, commonly contain coarse felspar crystals, often an inch in length. Besides these and some other eruptives on upper Boulder creek, there should be mentioned the diabase, weathering into a characteristic, yellowish-brown, gravelly soil, found in the upper shales, near the old quartzite, and consequently on the margin of the mountains. It occurs in a similar position in several other localities. Here it appears near Greyson and Boulder creeks, just before they flow out on the bench-land. **c**

Drainage.—The streams flowing from the Big Belt range all seem to be consequent upon its uplift. It is true that Deep creek rises well to the east of the old slate anticlinal axis, but it falls by a still greater distance to cut across the range. The present position of its source may result from a backward cutting of its headwaters.

A former lower elevation of the mountains is indicated by high, level benches, of not uncommon occurrence, in the basins of Deep and Boulder creeks. At several places their surface is remarkably smooth and nearly level, although quite independent of the rock structure below. South of Diamond City there is a strongly-marked bench of gravel with heavy boulders, in which gold-washing has been attempted, and is still continued with moderate success; but the present channel of Boulder creek is cut sharply down through this wash and into the slates, 50 to 70 feet below. The channeling of the open bench-land west of the mountain toward the Missouri has already been mentioned. The unsymmetrical form of the valley of Boulder creek—a long slope toward the mountains, **d** and an abrupt slope on the opposite side—is the result of the northward dip of the slates. A similar form is found on the North fork of Deep creek for the same reason.

Glacial action.—After the great blocks of granite on upper Boulder creek had excited our surprise and suggested the possibility of glacial action here, we saw a well-preserved lateral moraine stretching across a small side ravine farther up the valley. It was about 400 feet above the valley bottom, and a small marsh was inclosed behind it. No terminal moraines or scratches on boulders or ledges were found, but the lower limit of probable glacial action was estimated at 6,000 feet. Several small lakes are reported farther in toward the high mountain centers.

THE LITTLE BELT MOUNTAINS.

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Structure.—The Little Belt range begins, according to our maps, on the eastern side of Smith's river (Deep creek) and extends 50 miles to the east-southeast, with an average breadth of 20 miles. Our observations were confined to its western part, about the mining towns of Clendenin and Neihart, in the Barker and Montana mining districts, and here the trend of the range is much more nearly east and west than is usual among the Rocky mountains. For this reason we are disposed to bring the northern part of what is commonly called the Big Belt range within the structural limits of the Little Belt, and thus give it an extension of 10 or 20 miles west of Smith's river toward the upper Missouri. This mountain group seems intermediate, in character as well as in position, between the external and front ranges, and, at our line of crossing, presents several points of resemblance to the Black hills, as may be seen by comparing our structural section 4 with the figure in the report of the lamented Newton. About the upper branches of Belt creek the restored structure would show a broad arch, with the axis **f** nearly east and west, flattened on top into plateau form, and having dips of 5° to 15° on either flank. Mesozoic, as well as Paleozoic, strata were probably once continuous across this region, but erosion has now forced back the front of the more yielding Cretaceous layers southward beyond Sheep creek, and northward to the broad valleys of Otter and Arrow creeks, and worn away the great limestone series to Sheep creek on the south, and across Belt creek at the Park below Neihart on the north. (To the east or west of our section the formations have somewhat altered positions.) Between the limestone bluffs the old quarzite is exposed, lying almost flat, and, at places, is cut through to the underlying gneiss. In addition to the plateau structure, there is another equally characteristic, produced by the extrusion of heavy oval igneous masses through the stratified rocks, sometimes even to the top of the Carboniferous series, causing a strong but local uplifting of the beds immediately around the central core, and giving strong topographic forms, as will be described below.

a Section 4 and its relations to the districts east and west may now be described in more detail. The valley of Sheep creek, where followed by the road from White Sulphur Springs to Neihart and for several miles farther up stream, is as drawn in the section on a monoclinal of gentle southward dip. The stream has cut the middle Paleozoic strata down to the old quartzite, which rises slowly to the plateau benches on the north, while the opposite and bolder slope contains part of the great limestones. This limestone range is heavily wooded, and no good outcrops were seen from the valley; but from its sequence above the old quartzite, from its form and altitude, and from the occurrence of Carboniferous fossils in the stream, the above inferences seem safely based. Before going farther north, we may consider the western extension of this monoclinal. The quartzite ridge is its most persistent element; it reaches Smith's river in good strength, but disappears just beyond the southern flank of the Dry range of b Carboniferous limestones, the two evidently being separated by an oblique fault, with heavy downthrow on the north. (See Big Belt range, p. 706.) On the way here, the quartzite is three times cut through by streams flowing against its dip, but toward the downthrow side of the fault—namely, Sheep creek, Smith's river, and a small stream between the two. The monoclinal valley rises into two high grassy "cols" on the back of the quartzite between the three streams just mentioned. The limestone ridge loses its continuity opposite the quartzite cañon of Sheep creek; south of the second "col" it reappears in normal position for a short distance, but south of the first "col" there is an unexpected and unexplained butte of quartzite. When the monoclinal crosses Smith's river, it must be cut off on the south as well as on the north by a fault, for all the broad area from the Dry range nearly to Benton gulch is occupied by the old slates. We have supposed, although without final evidence, that these two faults converged c to the west with a narrowing area of Upper Cambrian rocks between them, and meet just beyond Smith's river where the strata of this age are absent.

Returning, now, to the section line and crossing the pass, we follow the quartzite so far that its repetition by faulting becomes very probable, especially as it has only a moderate thickness between the Archæan gneiss and the Potsdam limestones on Belt creek a little farther north. The occurrence of faults, as drawn on section 4, is further confirmed by the reported occurrence of what was called syenite by a local expert, just north of the first quartzite ridge; and a fault here would very probably be continuous with the northern of the two already mentioned, its throw increasing to the west. The quartzite district is not one of easy observation, as it is closely timbered or richly grassed to the concealment of most outcrops, to say nothing of the "terrible torment of flies" which makes summer work in the pine forests of the ridges almost unendurable. Where the nearly horizontal quartzite and d overlying shaly sandstones lie at a moderate altitude, they often form open, grassy parks, of which the most notable is a beautiful plateau, beginning about 3 miles west of Neihart and extending westward 6 miles with gentle slope, until covered by the limestones about Tillinghast creek. The absence of trees here seems quite independent of fires, and is doubtless inherent in the conditions of soil and surface. Pines of good size are plentiful on the rocky slopes below and above.

On descending from the pass and the glades on its northern side, the road leads down the narrow gorge of O'Brien's creek to Belt creek at Neihart. The quartzite is well exposed at several bench outcrops on the way, and a mile or more from Belt creek includes some 300 feet of soft, gray shales between its upper and lower members. The lower quartzite is two or three hundred feet thick, and lies directly on Archæan gneiss in marked unconformity, but the exact contact was not seen at any point. As the road descends with the stream deeper e into the gneiss, the quartzite rises gently, and around Neihart it caps several of the mountains 800 or 1,000 feet above the valley bottom, giving a broad example of nearly horizontal strata resting on the highly inclined gneiss. The lower layers here contain some white quartz pebbles, but the greater part is of fine texture. (The moderate thickness of this basal formation from the gneiss to the Potsdam limestones has already been mentioned, and has led us to suppose that we are here in the neighborhood of a Cambrian shore-line, as will be further stated below.) The gneiss is sometimes reddish, with faint foliation and of granitic appearance, and again dark, hornblendic, and well banded. Some blocks found in talus slopes showed the occurrence of intrusive red granite, not seen in place; probably of pre-Cambrian intrusion, as we could learn nothing of the granite rising into the overlying quartzite, although such an occurrence would doubtless have been discovered by some of the numerous prospectors who have searched the region for leads. The leads thus far found are in either gneiss or quartzite, f and yield lead and silver ores.

The broad, flat structural-arch of the range rises to the east, and, consequently, the Archæan rocks are exposed over a wider area in that direction; and this increase is further aided by a local upturning between Neihart and Barker. To the west we found the gneiss only in the narrow cañon of Belt creek, where it cuts the quartzite "Park". A few miles farther down-stream the quartzite itself passes below drainage level, and the great limestone series, now north of the arch axis, forms the fine bluffs along this creek and on its Dry fork. It was from these bluffs, opposite the "Park" on Belt creek, and at the point where the stage-road from Fort Benton enters the valley of Dry fork, that we obtained our best measures of thickness and series of fossils; the exposures could hardly be improved. Farther west the base of the series is not revealed; farther east it is largely removed by erosion or broken by eruption. Here it is exhibited in full strength, in simple and unbroken succession, and in numerous and easily accessible outcrops. On the Belt Creek bluffs we measured from the Archæan gneiss up through the Cambrian quartzites and limestones, past the barren, shaly, and sandy limestones, up to layers with lower

Carboniferous fossils, 2,300 feet above the creek. Then crossing about 2 miles to the north, the brown sandy **a** limestone, that was 1,800 feet above Belt creek, was found to have descended to the bed of the Dry fork, while the bluffs above it rose 800 feet to the heavy ragged limestones near the top of the Carboniferous. Finally, near the "summit", where the stage-road passes out to the open country, the ragged limestones run underground, and are overlain by the even-bedded barren limestones and shales and sandstones which lead up to the Mesozoic formations. The structure has all the simplicity and distinctness that one can desire, and there remains only to regret the lack of definite termination of the Paleozoic series. Carboniferous fossils were found 500 feet above the limestones which we had considered the top of the older formations, and beyond these 800 feet of sandy shales and sandstones were measured, and 3,000 to 4,000 feet more estimated, in which no fossils whatever were seen. These latter measures were taken from the northern side of an interesting dome-uplift outside of the mountain's margin, north **b** of Barker. It is surrounded by what we considered Jurassic and Cretaceous rocks, but shows the ragged limestones of the Upper Carboniferous over a circular area 2 or 3 miles in diameter at the center. As in the mountains themselves, the dips are steepest where these limestones run underground, but are moderate, not exceeding 10 or 20 degrees, unless close to the eruptives. A similar dome structure is reported by Mr. Eldridge, N. T. S., for a crater-like elevation farther southeast, near the margin of this range. In a region where orographic displacement is generally in the form of broad, flat arches or long, straight faults, we are disposed to attribute these local disturbances to the effort of incomplete massive eruptions, of which the complete form is described in the next section.

Igneous rocks.—Intrusive granite in the gneiss, probably of pre-Paleozoic date, has already been mentioned; **c** besides this, several other intrusives of equal antiquity were suspected, but opportunity was wanting to examine them. In the stratified rocks the intrusives had two forms—one in the massive outbursts of dacite, the other in dikes in the "Park" quartzite and shales on Belt creek. The latter have a thickness of 10 or 20 feet, and stand about vertical. They stand out in well-exposed walls in the side ravines of the Belt creek cañon; the adjoining rocks are not visibly distorted by them. The dacites form mountains of 1,500 to 2,500 feet altitude (above the surrounding country) and of considerable area. West of Tillinghast creek a mountain of this origin has cross-measures of about 1½ and 3 miles, and is notable for the oval form of its eruptive rock as well as for the small disturbance it produces in the adjoining rocks. It seems to be a vast chimney or "neck", from which the former filling of stratified rocks has been forced out by the thrust of the eruption; and where examined on the south, east, and north, the adjoining Cambrian strata were, with an insignificant exception, found to change abruptly from **d** the nearly horizontal position in the surrounding country to dips of 30° to 70° away from the contact—the breadth of this disturbed belt varied from 100 feet to one-quarter of a mile or more. A similar relation of the igneous and stratified rocks was noticed on the northern slope of the range that extends from the "summit" of the Fort Benton and Barker stage-road to the bridle-trail leading northward from Barker. The Upper Carboniferous limestones stand in steep triangular patches against the slopes between the ravines leading down from the marginal range of the Little Belt mountains; but here we were unable to define the shape of the igneous area. The date of the dacite eruption is certainly post-Carboniferous, and very probably agrees with that of the mountain uplift. There was nowhere any sign of eruptive overflow.

Drainage.—The streams in the mountain region generally flow away from the higher part of its arch, so far as examined, and may therefore be considered consequent; but Sheep creek and Smith's river have already been **e** referred to as flowing across the old quartzite ridge against its dip, and as the latter crosses the entire range and empties into the Missouri on the north, it especially may be of antecedent origin. Another interesting case, but of much smaller size, is seen on the southwestern side of the dome uplift of ragged limestones above mentioned, where a little stream from the higher range runs on the limestones from the south, cuts a cañon 100 to 200 feet deep across them, like the chord of a 60° arc, and flows out and away on the west.

No signs of glacial action were found in this range.

THE HIGHWOOD MOUNTAINS.

Structure and rocks.—The Highwoods present a good example of one type of the external ranges. They stand completely isolated in a surrounding of nearly horizontal late Mesozoic rocks which make a dry, open, somewhat **f** broken country, above which the peaks rise 3,500 feet. The group is about 15 miles long east and west, and 12 miles wide. It consists, where we crossed it at Highwood gap, near the middle, of slates or slaty sandstones, nearly horizontal or irregularly tipped to a moderate dip which seldom exceeds 25°, cut and indurated by numerous dikes of varied composition, running in all directions, standing in all altitudes, and frequently intersecting one another; 5 to 10 feet is a common thickness for the smaller ones; 100 or more feet for the larger. No massive eruption was found on our line of observation, though such may occur among the higher mountains. The dikes often resist weathering less successfully than the adjoining slates that they have baked and hardened, and consequently are not always well exposed; indeed we found it difficult to obtain proof of their relative ages, so generally are the intersections covered. In some cases they stand out like walls, then making serrated ridges if of large size, but more generally their position is marked by faint outcrops, or by lines of greener grass than on the

a neighboring slates. Looking from the peaks north of the pass the grass-lines on the foot-hills reveal very clearly the great number and varied attitude of the dikes. About two miles southeast of the pass there is a mass of volcanic conglomerate 200 or 300 feet thick, composed of rather coarse cobbles of dacites, unlike the many eruptives of the range, but allied to the massive eruptions of the Little Belt mountains.

The shales and slates present no notable features; they run through the common varieties of color and composition, the colors being gray, bluish, and brown, and the impurities consisting chiefly of fine sandy material. There are no well-marked layers serving as indices to faults and folds, so that little can be said of their position. They apparently overlie the Cretaceous south of the range and the dark (Benton) shales which soon appear in the *coulées* to the north.

b *Drainage.*—On account of the absence of strata of effective hardness and of master-dikes there seems to be no system or regularity in the form of the mountains or in the arrangement of the valleys. The former culminate in ridges and rounded peaks, from which serrated spurs wander out to the lower country. The upper valleys are all steep sided, V-shaped, and without benches; evidently the processes of deepening and widening are here going on together, and there is no evidence that these upper streams have ever reached a base-level of erosion. The lower valleys—for example, that of Highwood creek—show on the other hand a distinct flood-plain between well-marked benches or terraces that are quite independent of the rock structure, and thus prove a former relatively lower level of the mass, preserved long enough to allow the streams to cut down their channels close to the then base-level of drainage, and accomplish something of the widening of the valleys by lateral cutting; all this followed by a general c uplift which restored the deepening action of the streams and enabled them to cut cañon-like clefts in their old flat bases; now succeeded in the outer valleys by a second period of lateral cutting. Where Highwood creek leaves the mountains it has already widened this newer cañon into a flat-bottomed valley broad enough for cultivation. The higher benches also yield good grain-crops wherever water can be carried over it from the upper streams. The elevation indicated by these benches is in the neighborhood of 100 feet.

THE PLAINS AND THE MAIN RANGE.

The journey from Fort Benton, on the Missouri, westward across the plains and over Cadotte's pass, on the main range of the Rocky mountains, gives a beautiful example of the gradual change of structure and topography encountered in going from one of these great geographic types to the other.

d The plains from Fort Benton to Sun river consist of essentially horizontal Cretaceous strata, with gently-rolling surface. Excepting near the rivers and *coulées* the local relief is seldom more than 30 to 50 feet in a mile, and this only in undulations of great breadth. The drainage lines are of older and newer origin. The older are seen in the broadly-open, flat depressions extending with curvature of long radius for miles across the country, followed by insignificant streams, or sometimes sinking into faint basins for very shallow alkaline lakes or sloughs. All these we consider the work of a river system now extinct, a system that, when in activity, cut and carried away an unknown thickness of overlying strata and brought the original surface down near its base level of drainage, thus producing the comparative smoothness of the existing plains. But later, and very probably at the time when the intermontane lakes were formed, the rivers of this old drainage system were turned from their flat courses by a tilling and elevation of the country, and then the second and still existing system of drainage was instituted.

e The large rivers, such as the Missouri, have cut deep, but comparatively narrow and steep-sided trenches, often in soft rocks, to 400 feet below the old level; but the work thus far accomplished in this new altitude is a very small share of what can be done if the existing elevation above the level of discharge be maintained. On the Missouri there is evidence of a pause in the assumption of the present altitude in the existence of a broad bench—which seems to be a temporary "base-level" held during the change of altitude—250 to 300 feet above the river; but on the Teton, where seen, about 25 miles from Fort Benton, this intermediate bench is not visible. Keeping pace with the deepening of these larger channels, the small lateral streams have cut ramifying ravines in the river banks, making a very rough, almost impassable country, from 1 to 3 miles wide, known as "*the breaks*"; and still smaller streams, probably following new directions since the last tilting of the country, have cut distinct, narrow, but shallow channels on the steeper slopes of the old eroded surfaces. In general the new drainage lines have f channels proportional to the volume of their wet-weather streams, while the broad old channels are either dry or swampy, or are followed by streams of comparatively small size. Where they hold shallow lakes the basins may plausibly be ascribed to the obstructive action of new streams depositing their alluvial deltas in the old channels. The thickness of strata destroyed in carving out the present general surface of the plains can only be inferred by an extended study of the Cretaceous strata over a broad region; and this we have had no opportunity of making. But the Highwood and Crazy mountains probably give a minimum measure of 3,000 to 5,000 feet of erosion on the country around them, and the plains are therefore to be regarded as plains of denudation, cut down to an old base-level of erosion.

The drift of pebbles and boulders that occurs plentifully over the plains is of peculiar interest. We encountered it first on the plains north of the Highwood range to the Missouri, and again on the way from Fort Benton nearly to Sun river. It may be subdivided into two classes, of which one consists of smaller, well-rolled

stones, 6 to 8 inches in diameter, commonly of hard gray, yellow, or purple sandstones, or sometimes of gneiss, **a** generally associated with 5 or 10 feet of fine (yellow), apparently bedded clay, and spreading over the lower bench (250 feet over the Missouri), as well as on the higher level of the plains. The other class of drift includes the angular and subangular and occasionally scratched stones and boulders of all sizes, up to 2, 3, 4, and even 5 feet in diameter, mostly of red or gray granite and gneiss; also of fine, firm sandstones, lying, so far as found, on the surface of the ground. Section exposures were uncommon, and hence we have not full assurance of the constancy of these characters. It is noteworthy that the drift does not extend across the higher, rougher country west of Sun river to the foot of the mountains, and that the source of the large granitic boulders, at least, is not to be looked for in the mountain ranges of central Montana. They come from the north or northeast, not from the west, and should be associated with the numerous heavy boulders of the plains west of the Missouri at Bismarck; with the boulders described by Dr. I. C. White on the Yellowstone; and with the drift along our northern boundary **b** as described by Mr. G. M. Dawson. In view of the thinness of the drift deposits, and the absence of those forms of drift commonly found farther east where we suppose land-ice has acted, we must ascribe this drift of the plains to the action of running water from the west and floating ice-bergs from the east, not to a land ice-sheet. This implies great changes of level since the drift period.

The plains are absolutely treeless; but on the flood-plains of the larger streams there is a plentiful growth of large cottonwoods and small willows, wild cherries, and various bushes. Grass is generally excellent, but there are broad areas where it cannot be pastured on account of the distance to water. Hay is cut by machine for the stage-stations at $12 a ton.

The strata maintain a nearly horizontal position beyond Sun river, and the first clear sign of disturbance is **c** the appearance of eruptive rocks—chiefly basaltic—about 6 miles southwest of Sun river crossing, or Fort Shaw. They occur as sheets and as dikes, and from both a minimum measure of the erosion suffered by the plains here can be obtained. The sheets form typical *mesas*, as in Table and Twin buttes, between Sun river and Bird Tail creek. The hard strata of basalt here are 200 or 300 feet thick (600 to 800 feet above the surrounding country), and seem to lie conformably on their pedestals of horizontal Cretaceous beds, as if of contemporaneous overflow origin, a supposition confirmed by finding a heavy bed of basaltic conglomerate in the Cretaceous series some 15 miles farther west. We may, therefore, believe that Cretaceous times witnessed volcanic activity in the neighborhood of the mountains.

The dikes of basalt are of all sizes, and exert all grades of influence on the topography. Being, as a rule, distinctly harder than the adjoining strata, they stand up in ragged, serrated ridges, most commonly with a **d** northwesterly trend, and a nearly vertical attitude when their dip is determinable. They are very numerous east of the Dearborn river crossing, and have their finest development in the Bird Tail butte and several other similar sharply outlined ridges south of the Fort Benton-Helena stage-road, where their width may be at least 1,000 feet, their height above the adjoining valleys 800 feet, and their visible length about a mile. Four of these buttes are on a straight line, about five miles long, and seem to be points of stronger outbursts on a single fissure of varying width. All the submountainous topography of this region is due to the presence of the eruptive rocks; the sedimentaries still lie essentially horizontal until near the Dearborn river, and the smooth surface of the plains would undoubtedly extend 10 or 20 miles southwestward of its present limits if its erosion here has not been locally retarded by the hard dikes and sheets. When the erosion began the Cretaceous strata must have been at least as high as, and probably higher than, the present summits of the buttes and mesas; so we may infer a subsequent denudation **e** of at least 1,000 feet over all the neighboring plain country. The contemporaneous erosion over many of the adjoining mountain ranges must have been certainly vastly in excess of this measure, the difference in the two amounts being most likely due to their different altitudes above the level of drainage discharge.

The relation of the several features of the plains now described is of importance. Their comparatively smooth surface is not a form of original deposition, but results from the denudation of a broad sheet of strata, as is shown by the attitude of the mesas and dikes. There is every reason to think that this denudation is the work of rain and rivers; but in order that these agents should produce a smooth surface they must perseveringly act until their valleys widen and consume the intervening hills and reduce the surface nearly to the base level of erosion. It thus follows that the present elevated surface of the plains stood for a long period through Tertiary and early Quaternary time close to the level of drainage discharge. The same conclusion is suggested by the broad distribution of ice- **f** rafted boulders of northeastern origin. Subsequent to the general erosion and to the importation of the boulders, the plains gained their present elevation. We are, therefore, led by two independent lines of evidence toward the same series of events in the history of the plains.

After passing the main stream of the Dearborn river, the eruptive rocks decrease in strength, and their topographic force is replaced by the tilting of the bedded rocks. Cross-section 8 shows some moderate dislocation before reaching the river; but on crossing the Dearborn anticlinal, a distinct westerly dip is maintained almost without interruption 15 miles across strike, up the Middle fork to the divide at Cadotte's pass. If there were no repetition by faulting, the beds here seen would measure 40,000 feet. But repetition by faulting must necessarily occur, for the coal horizon is passed at the Dearborn, and Cambrian slates occur in the main ranges; the difficulty in the case lies in determining the lines of fracture. Nearly all the beds are without fossils, and, before reaching

a the mountains, broad areas of flat bench land are covered over with stony "wash" in which outcroppings are very rare. We have, therefore, to offer only a very general explanation of the mountain structure. The Upper Cretaceous, probably repeated by faults, may be considered as reaching up to Gillette's winter ranch, 6 miles beyond the strike of the coal outcrop. Here a projecting spur, southeast of Middle fork (not shown in section 8) is found, capped with hard sandstone, shales, and thin limestones, and flanked with greatly shattered masses of heavy limestone, in which the dip is very indistinct. This we have interpreted as marking a fault of enormous throw, by which the Cambrian quartzite and trilobite limestones are lifted up against the Upper Cretaceous; the uplift must measure 15,000 feet or more. The shattered limestone is probably Upper Carboniferous, caught in the fissure. The line of dislocation marking the separation of newer and older rocks does not, at this point, run with the prevailing strike of the b district, but bears obliquely to the west, for the quartzite spur does not reach the Middle fork, and a ridge of the same quartzite, repeated a little farther southwest by a strike-fault of moderate throw, is cut off a little northwest of the stream. This quartzite ridge (see section 8) is overlaid by the same shales and thin-bedded limestones as were found on the spur; and although no trilobites were found here, even after much searching, the strata may pretty safely be regarded of Cambrian age. No higher rocks are found, for another strike-fault, again with uplift on the west like all the faults of this side of the mountains, brings up the variegated slates of the Lower Cambrian, which continue with fault-repetitions to the summit of the range.

An easy and well-marked Indian trail leads over Cadotte's pass, a continental divide, at an altitude of about 7,000 feet, and then descends south and southwest to the headwaters of the Little Blackfoot. The surrounding c mountains reach a height of 9,000 feet or more, and are all composed, from valley bottom to summits, of the Cambrian strata. A mile or two after crossing the pass, the beds lose their southwest dip toward the axis of the range, and become horizontal, and a little further are elevated so as to dip northeast. Going down the Little Blackfoot the exposures soon become very poor, but when seen the northeast dip is still maintained, and the rocks could be better referred to the Cambrian than to any other formation, even beyond Lincoln, twenty miles from the divide. The upper part of the Little Blackfoot cañon, just below Lincoln, our farthest point southwest from the pass, still retained the northeasterly dip, and was still of slates and slaty limestones without fossils. The main range may therefore be regarded as a broad, flat synclinal of the oldest bedded rocks, repeatedly broken by faults generally parallel to its axis, with downthrow on the outer side. This structure is in marked contrast with that of the Big Belt mountains, and indeed is quite opposite to the conventional structure of a mountain range; but according d to Mr. Pumpelly's observations, it persists for several hundred miles to the north. Within the mountain region eruptives appear but seldom, the Cambrian diabase being noted only in a few places.

Drainage.—The streams are here about square with or parallel to the strike of the rocks, and the cross-streams flow away from the synclinal axis on either side of the range. It may therefore be supposed that a longitudinal elevation was first formed on the mountain-line, determining the water-courses, as well as giving the Cambrian rocks here their considerable elevation; and that, at some later time, lateral uplifting and faulting produced the well-marked synclinal structure, but without sufficient violence to displace the streams. Old base-levels, cut by narrow stream-channels at many points, mark recent massive changes of elevation.

Local glacial action.—On descending the southwestern slope of Cadotte's pass and joining the upper waters of the Blackfoot, we passed the meadow of an extinct lake, now occupied by many beavers, and camped on a moraine e barrier, about 6 miles from the pass. The moraine had numerous quartzitic stones that we had not seen in place, and many of them were well scratched. Good exposures of unstratified drift were seen in some fresh stream-cuts. It was at first supposed that the glacier which formed this moraine had come from the neighborhood of the pass; but further examination of the distribution of the drift, and its absence from the valleys near the main divide, showed that the ice-fields had been to the northwest instead, where the main range rose higher, and whence the glacier had followed lateral valleys down to the Blackfoot. Other moraines were seen near Lincoln. About Cadotte's pass there was no snow on the surrounding mountains in August; and on the eastern slopes no local glacial action was observed.

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Appendix A.—REMARKS ON THE FOSSILS IN THE FOLLOWING LISTS.

By R. P. Whitfield.

There are four principal horizons represented among the following lots of fossils, namely, Potsdam or Primordial, Lower Carboniferous, Jurassic, and Cretaceous. The species of Potsdam fossils represent only one horizon or bed, so far as can be determined from the imperfect material. There are probably not more than three, or at the most four, species present in the whole, and I think most likely not more than two good species, as some of those marked as new (?) may possibly be the young of the larger forms. Still, with more critical study and comparison than is possible by looking over a single lot at a time, as I have had to do, there is much chance for error from recollection.

The Lower Carboniferous may be all of one horizon or bed, but there are evidences of more. In some of the lots there are forms which more properly characterize the Keokuk horizon than others. Of this kind *Spirifera*

striata may be said to be the most marked one. *Spirifera pseudolineata*, Hall, is another, and is present in only a a very few lots. A second horizon is very much better represented in forms which are the same as those which are found in the Spergen Hill beds of Indiana and Illinois. These beds hold a position higher than the Keokuk beds, and as represented here would be equivalent to the Warsaw and Saint Louis horizons of the Mississippi River region. Many of the lots which contain several of the Spergen Hill species also contain forms which are more characteristic of the Chester limestone horizon. These contain the *Productus pileiformis*, McChesney, and *Spirifera setigera*, Hall, though it is possible, and even highly probable, that in this set of localities these forms all exist in a single bed or in a series of beds without zoölogical unconformity. A third set of lots I would call attention to, viz, those in which *Strophomena rhomboidalis* occurs. This series possesses features that would seem to ally its horizon more distinctly with the real Waverly group—Kinderhook group of Illinois Geological Reports. These beds b appear to lie at the base of the Lower Carboniferous series, and it would be interesting to know if at these western localities they hold a similar position, or if the *Strophomena* passes entirely through the Lower Carboniferous formation.

There are a few of the fossils in these Lower Carboniferous layers represented which need particular mention in consequence of their peculiarities. Among these the *Streptorhynchus*, found in so many of the lots as to be nearly universal, is a most puzzling one. Among the individuals represented in the collections there are specimens which might be classed under several names. But as the forms of this genus are so very variable wherever found, I have not considered it of sufficient importance to indicate them by specific names in many, other than the first examined lots, and I think it more than probable that if the lots from each locality were collected together it would be c found that all the forms are present from each of the distinct localities. The forms to which I refer represent *S.*, (*Orthis*) *æquivalvis*, Hall, and *inflatum*, White & Whitf., *S.* (*Orthis*) *Keokuk*, Hall, and *S. kaskaskiense*, McChesney, and *S.* (*Hemipronites*) *crassum*, M. & W. The first two are from the Waverly of the Iowa section, *S. Keokuk* from the Keokuk limestone, *S. kaskaskiense*, McChesney, from the Chester limestones, and *S. crassum*, usually found in the true Coal Measures, though recognized by Meek as common in the Chester beds both in the Mississippi valley and in West Virginia. *Spirifera centronata*, Winchell, is also a form which runs through most of these lots. In the Mississippi Valley region it characterizes the Waverly, and is seldom found above that horizon, but here it seems to be common everywhere, and I have found it to be the same in the Black Hills collections both from Captain Ludlow's expedition collection and from those brought back by the expedition under Henry Newton and W. P. Jenney. d

There seems to be a remarkable absence of forms which characterize the Coal Measures of other regions of the Rocky mountains. This is more particularly the case than among any collections which I have ever examined from this range of mountains.

The Jurassic species appear to be all from a single horizon, and might be supposed to have come from a single locality as far as any diversity of character among them is concerned. An absence of the sandstones so abundant among the Black Hills Jura is a remarkable feature.

The Cretaceous fossils are apparently all from a single horizon, and would be classed as No. 2 generally, although they partake somewhat of No. 3, so that I am inclined to think that both horizons are here blended together.

List of fossils from central Montana, determined by R. P. Whitfield. e

[The numbers of sections and fossil localities here given agree with those on Mr. Davis' Figs. 238 and 239.]

Section.	Number.	Description.	Formation.
1. Yellowstone Lower cañon	1	Cast of Ostrea or Gryphæa	Cretaceous, 2 or 3.
		Imprint of Inoceramus undabundus	
	2	Camptonectes extennatus, M. ?	Jurassic.
		Camptonectes bellistriata, M. & H	
		Gervillia Montanensis, Meek	
		Gervillia, sp. nov	f
		Perna	
		Pinna, sp. nov	
		Grammatodon inornatus, M. & H	
		Lucina, sp. nov	
		Tancredia ? sp. undes	
		Pholadomya Kingi, Meek ?	
		Ammonites cordiformis, var. *distans;* and a fragment.	
		Mytilus Whitii, Whitf. ?	
		Homomya ? sp. nov	
		?——, like Tellina; gen. and sp. nov	
		Ostrea strigilecula, White	
		Pleuromya subcompressa, Meek; M. & H	
		?——, like Perna; gen. and sp. nov	
		Pinna ? fragments	
		Volsella subimbricata ? M	
		Pecten ? fragment of a large costated sp	

List of fossils from central Montana, determined by R. P. Whitfield—Continued.

Section.	Number.	Description.	Formation.
1. Yellowstone Lower cañon	2	Trigonia Montanensis, M.?; fragment	
		Trigonia, sp. nov	
		?——, Bivalve; gen. and sp. nov	
		Corbula, sp.?	
		?——, two new forms; gen. and sp. nov	
		Goniomya Montanensis, Meek	
		——, allied to *Goniomya*; sp. nov	
		——, allied to *Goniomya*; gen. and sp. nov	
		——, allied to *Astarte Packardi*, White	
		Naticops, sp.?; internal cast	
		Echinoid, new form	
	3	Syringopora	Loose fragments; Lower Carboniferous, with last specimen Jurassic.
		Conophyllum, like *C. Sedaliensis*, White	
		Spirifera Rockymontana?	
		One specimen with Grammatodon inornatus, M?	
	4	Streptorhynchus, fragment very large	Lower Carboniferous.
		Spirifera centronata, Winchell	
1 A. South of Muir	5	Pinna Lakesi, W.?	Cretaceous, 2 or 3.
		Inoceramus umbonatus, M. & H.?	
		Inoceramus problematicus	
		Inoceramus undabundus	
		Inoceramus, fragments	
		Ostrea congesta, Con.?; perhaps a Gryphæa	
		——, resembling *Mactra Siouxensis*, Meek	
		Ostrea strigilecula, White	
		Ostrea or Exogyra, sp.?	
		Natica, sp.?; imperfect casts	
		——, like Turritella, casts	
		Exogyra, sp.?; possibly young of *Ex. costata*	
		Gryphæa, probably like *G. vesicularis*, Lam. (Meek.), but more likely an undescribed species, as it is not vesiculose.	
		Gyrodes depressa, Conr	
		Ostrea congesta, Conr	
		Pteria, sp.?; like *Pt. linguiformis*	
		Pholadomya Berthoudi, White	
		Naticopsis (Gyrodes) depressus, M. &. H	
		Glycimeris Berthoudi, White	
		Panopea or Glycimeris, possibly young of *Gl. Berthoudi*.	
		Belemnite, poor specimen; Jurassic?	
2. Flathead pass, Bridger range	6	Ostrea or Gyphæa, small fragments	Jurassic.
		Camptonectes bellistriata, M. & H	
		Bivalves, indeterminate	
	7	Spirifera Rockymontana, Marcou	Horizon of Coal Measures, but in Rocky Mountain region often in top of Lower Carboniferous.
		Athyris subtilita, Hall	
	8	Crinoidal fragments	Lower Carboniferous.
		Syringopora, as in (3)	
		Fenestella, sp.?	
		Stictopora, as in (18), (34), (35)	
		Spirifera centronata, W	
		Spirifera, like *Rockymontana*	
		Athyris, sp. indet	
		Rhynchonella mutata, H	
		Platycrinus, sp. like (19)	
		Bryozoans	
		Chonetes Illinoisensis, M. & W	
		Spiriferina spinosa, fragment	
		Platyceras, sp.?; like *P. acutirostris*, H	
	9	Productus Rogersi, N. & P	Should be Coal Measures.
3. Wall mountain	10	Syringothyris	Lower Carboniferous.
		Zaphrentis centralis, Ed. & H.?	
		Streptorhynchus, as in others	
		Spirifera striata, Sow	
	11	Streptorhynchus, as in others	Base of Lower Carboniferous. Waverly.
		Productus, like *P. hirsutus*, H	
		Productus, like *P. elegans*, N. & P	
		Spirifera centronata, Winch	
		Spirifera setigera, H	
		Spirifera lineata, Mart	
		Orthis Michelina	Lower Carboniferous.

List of fossils from central Montana, determined by R. P. Whitfield—Continued.

Section.	Number.	Description.	Formation.
3. Wall mountain		Chonetes, sp.?	
		Productus, small sp., as in (19), (20), (13)	
		Productus, like *P. Nebrascensis*, Owen, but flat	
	12	Fenestella, as in (34), (35), (23), (19), (18)	
		Stictopora, as in (34), (35), (18)	
		Trematopora, sp. undescr	
	13	Crinoidal remains	
		Productus, sp. nov., as in (19), (20)	
		Productus, like *P. Nebrascensis*, Owen	
		Spirifera centronata, W	
		Spirifera setigera, H	
		Orthis, sp.? young of O. Michelina?	
		Streptorhynchus, as in others	
		Chonetes, like *Ch. planumbona*, M. & W	
		Eumetria Verneuiliana, H	
		Rhynchonella mutata? H	
		Terebratula turgida, H	
	14	Lithostrotion?	
		Cyathoxonia, sp. undescr	Lower Carboniferous, probably low down, but containing evidence of higher beds as well.
		Productus semireticulatus?	
		Productus semireticulatus? Mart, variety	
		Productus, like *P. Indianensis*, H	
		Athyris sublamellosa, H?	
		Platyceras, like *P. symmetricus*	
		Platyceras acutirostris, H?	
		Orthis, sp. indet	
		Spirifera centronata, W	
		Sp. pseudolineata, H	
		Spirifera striata, Mart	
		Sp. setigera, H	
		Eumetria Verneuiliana, H	
		Rhynchonella mutata, H	
		Terebratula turgida, H	
		Crinoidal remains	
		Stictopora, sp. undescr	
		Glauconome, as in other lots	
		Orthis, small, like *O. Michelina*	
		Strophomena rhomboidalis, Wahl	
		Retzia punctulifera, Shum	
		Aviculopecten, sp.?	
		Allorisma, sp.?	
		Schizodus, sp.?	
	15	Zaphrentis, sp.?	Probably very base of Lower Carboniferous, but has a decidedly Devonian aspect.
		Orthis, imperfect, like *O. Michelina*, D K	
		Streptorhynchus, large, sp.?	
		Strophomena rhomboidalis, Wahl	
		Productus, like *P. spinulicosta*, H	
		Productus semireticulatus, Mart	
		Spirifera centronata, Winch	
		——, like young of *Atrypa reticularis*, cast	
		Euomphalus, sp. indet	
	16	A single shell, like *Obolella*	Potsdam?
		Fragments of trilobites	
	17	Conocephalites	
Section 4. Little Belt, west of Barker	18	Lingula, sp.?	Lower Carboniferous. Some of these are marked like Spergen Hill beds, Indiana, and Warsaw and Saint Louis limestones.
		Productus tenuicostatus, H.?	
		Fenestella, sp. Nos. 1 and 2	
		Stictopora, like Spergen Hill, sp	
		Rhynchonella mutata, H.?	
		Productus tenuicostatus, H	
		Athyris trinucleata, H	
		Eumetria Verneuiliana, H	
		Rhynchonella mutata, H.?	
		Terebratula turgida, H	
		Allorisma, sp. undes.?; allied to *A. sinuata*, McCh.	
	19	A bold limestone bluff on Dry Fork, Belt creek, 6 miles below Barker, yielding fossils, collected in groups, as follows:	
		About 350 feet above base:	
		Michelina expansa, White	Lower Carboniferous, with a decidedly Waverly aspect in some of the lots, approaching Devonian, while many of the fossils indicate a Keokuk and Warsaw limestone horizon.
		Streptorhynchus, resemb. *S. Chemungensis*, Con	
		Orthis Michelina, L'Eveille	
		Productus, sp. closely resemb. *P hirsutus*, Hall	

List of fossils from central Montana, determined by R. P. Whitfield—Continued.

Section.	Number.	Description.	Formation.
Section 4, Little Belt, west of Barker.	19	Productus, sp.?; small species, probably undescribed.	
		Spirifera centronata, Winchell	
		Crinoid stems and plate, *Platycrinus?*	
		About 220 feet above base:	
		Streptorhynchus, as above	
		Chonetes Illinoisensis, M. & W	
		Spirifera centronata, Winchell	
		Spirifera setigera, Hall	
		Spiriferina spinosa, N. & P	
		About 200 feet above base:	
		Plates of Crinoides, *Platycrinus?*	
		Streptorhynchus, as above	
		Chonetes Illinoisensis, M. & W	
		Spirifera centronata, Winchell	
		Eumetria Verneuiliana, Hall	
		Rhynchonella mutata, Hall?	
		Productus semireticulatus, Mart	
		Productus, small species as in No. 1	
		Bellerophon, sp.?; internal cast only	
		About 170 feet above base:	
		Streptorhynchus, as above	
		Chonetes Illinoisensis, M. & W	
		Spirifera setigira, Hall	
		Spiriferina spinosa, N. & P	
		Athyris, sp. too poor for determination	
		Terebratula formosa, Hall	
		Zaphrentis, sp.; *Z. centralis*, Ed. & Haime?	
		Crinoid columns	
		Streptorhynchus, somewhat resembles *S. crassum*, M. & W.	
		Productus semireticulatus, Mart	
		Productus pileiformis, McChes	
		Productus, sp. allied to *P. Nebrascensis*, Owen	
		Spirifera centronata, Winchell	
		Spirifera setigera, Hall, res. *Sp. pseudolineata*, Hall.	
		Athyris hirsuta, Hall	
		Eumetria Verneuiliana, Hall	
		Rhynchonella, sp.?; new form	
		Platyceras, sp.?	
		Pleurotomaria, sp., new	
		About 130 feet above base:	
		Streptorhynchus, as in first	
		Chonetes Illinoisensis, M. & W	
		Productus semireticulatus, Mart	
		Spirifera setigera, Hall	
		Eumetria Verneuiliana, Hall	
		Fifty to 100 feet:	
		Zaphrentis, sp. resemb. *Z. centralis*, Ed. & H	This lot always appeared to me to have been mislabeled, as it accords so well in its Bryozoa with lots from a different locality. Otherwise it agrees with these. R. P. W.
		Platycrinus, sp. new; same as plates in other lots.	
		Polypora, sp.?	
		Fenestella, sp.?	
		Glauconome, sp	
		Strophomena rhomboidalis, Whal	
		Productus pileiformis, McChes	
		Productus semireticulatus, Mart	
		Productus, sp.? resembl. *P. Nebrascensis*, Owen.	
		Spiriferina spinosa, N. & P	
		Eumetria Verneuiliana, Hall	
		Athyris hirsuta, Hall?	
		Terebratula formosa, Hall	
		Euomphalus laxus, White	
		Loxonema, sp.?	
		Chonetes, sp.? resembl. *C. planumbona*, M. & W	
		Streptorhynchus crassum, M. & W.?	
		Productus Nebrascensis, Owen?	
		Productus Prattenanus, Norwood?	
		Spirifera centronata, Winchell	
		Spirifera (Martinia) lineata = ? *S. planoconvexa*, Sh.	

List of fossils from central Montana, determined by R. P. Whitfield—Continued.

Section.	Number.	Description.	Formation.
Section 4, Little Belt, west of Barker..	19	Athyris, sp. like *A. subtilita*, Hall	
		Athyris, sp. ? like *A. planosulcata*, Phil	
		Syringopora, sp. ?	
		Chonetes planumbona, M. & W. ?	
		Productus, sp. ?	
		Spirifera, like *S. striata*, Mart	
		Spirifera Rockymontana, Marcou	
		Rhynchonella, sp. ?	
		Terebratula formosa, Hall	
		Platyceras acutirostris, Hall	
		Zaphrentis, sp. ? like *Z. centralis*, Ed. & H.	
		Cyathophylloid coral, genus undetermined	
		Lithostrotion, sp. ?	
		Spirifera, sp. ? like *S. Rockymontana*, Marcou	
		Spirifera ? possibly dorsal value of a *Syringothyris*, sp. ?	
		Naticopsis or Euomphalus, very imperfect	
	20	Streptorhynchus, as in other lots	Lower Carboniferous.
		Chonetes Illinoisensis	
		Chonetes, like *C. planumbona*, M. & W	
		Productus, like *P. Nebrascensis*, id. like (19)	
		Productus semireticulatus, Mart	
		Spiriferina spinosa, N. & P	
		Zaphrentis centralis, Ed. & H. ?	
		Fenestelloids	
		Trematopora, like *Bryozoans*	
		Stictopora, as in other lots	
		Terebratula formosa, H. (a little doubtful)	
		Spiriferina centronata, W	
		Athyris hirsuta, H., very large, approaching *A. sublamellosa*, H.	
	21	Zaphrentis, sp. unknown	Somewhat the aspect of Upper Carboniferous; may be top of Lower Carboniferous, or possibly Coal Measures.
		Fenestella, sp. undet	
		Spirifera, like *S. centronata*	
		Spiriferina, perhaps *S. Kentuckensis*	
		Spiriferina, perhaps *S. spinosa*	
		Athyris, like *A. subtilita*	
		Rhynchonella mutata, H	
		Orthis, like *O. Michelina*	
		Favosites, or Chætetes, small cells, sp. ?	
		Streptorhynchus	
	22	Conocephalites, two sp	Potsdam.
5. Little Belt mountains, Otter creek.	23	Fenestella	Lower Carboniferous.
		Fragt. Zaphrentis	
		Spirifera centronata, Winch	
	24	Syringopora	
		Zaphrentis	
		Streptorhynchus, as in other lots	
		Orthis dubia, H	
		Spirifera striata	
		Chonetes, fragments	
		Athyris, fragments	
		Terebratula, = T. turgida ?	
		Rhynchonella mutata, H	
		Bellerophon	
	25	Dikellocephalus, sp. nov., like *D. Minnesotensis*	Potsdam; probably higher than other Potsdam rocks.
		Conocephalites, sp. nov	
6. Big Belt mountains, Benton gulch..	26	Conocephalites, sp. nov	Potsdam.
		Conocephalites, like *C. minor*, Shum	
7. Big Belt mountains, Boulder creek.	27	Hyolithes, primordialis, Hall ?	Potsdam.
		Hyolithes, like *H. gregarius*	
		Crepicephalus, sp. undescr	
		Trilobite fragments	
		Orthis Michelina	Lower Carboniferous.
		Chonetes Illinoisensis, M. & W	
		Chonetes, small, like *C. setigera*, H	
		Platycrinus	
		Spirifera centronata, Winch	
		[These are from a disordered region but we supposed them to be all one formation. W.M.D.]	

List of fossils from central Montana, determined by R. P. Whitfield—Continued.

Section.	Number.	Description.	Formation.
8. Main range	29	Fragments, apparently of an oyster	Indet. Mesozoic.
4. Highwood mountains	30	Ostrea, fragments, may be *O. congesta*, Conr	Cretaceous.
		Ostrea congesta	
		Inoceramus, doubtful sp	
		Fish-bones and scales	
		Inoceramus, sp. nov	
	31	Fragment of bivalve shell, like *Unio*	
		——, possibly Oxytoma mucronata, M. & H.; if so, is Jurassic.	
		Plants	
	32	Cast of Bivalve, like *Sphæriola?*	Cretaceous?
		Ostrea congesta, Conr.?	
		? Imprint of Ammonite?	
6. Dry range	33	Chætetes or sponge	Lower Carboniferous.
		Fragments of Zaphrentis?	
		Productus pileiformis, McCh	
		Productus semireticulatus, Mart., form like P. bimesialis, H.	
		Spirifera centronata, W	
		Spirifera striata	
		Spirifera, like *S. lineato*, Mart	
		Rhynchonella mutata, H	
		Rhynchonella, sp.? new to Lower Carb., very closely like Silurian form.	
	34	Zaphrentis, imperfect	Near base of Lower Carboniferous or Waverly.
		Fenestella	
		Glauconome	
		Streptorhynchus, like *S. crassum*, M. & W	
		Productus, like P. bimesialis, H	
		Spirifera centronata, W	
		Spirifera pseudolineata, H., or setigera, H	
		Spirifera planoconvexa, Shum.?	
		Athyris hirsuta, H	
		Rhynchonella, sp. undet	
		Euomphalus, like *E. laxus*, White	
	35	Fenestella, as in (34); Glauconome, as in (34)	Lower Carboniferous.
		Streptorhynchus, very small sp	
		Strophomena rhomboidalis, Wahl	
		Productus, a form of *P. semireticulatus*, Mart	
		Productus, like *P. Shumardi*, H	
		Spirifera setigera, H	
		Spirifera, sp.? like *S. scobinata*, Meek	
		Spirifera centronata, W. (young)	
		Athyris or Nucleospira	
		Rhynchonella mutata, H	
		Rhynchonella, sp. nov., remarkable form	
		Terebratula sp.? large form, like *T. inornata*, McCh., but truncated in front; not T. turgida, H.	
		Terebratula formosa, H	
		Platyceras, like *P. ammon*, W. & W	
—— Mullen pass		On pass, Spirifera centronata, W	
		On limestone range, 3 miles west, Spirifera striata.	
In valley of Little Blackfoot river, 2 miles above Logan's ranch.		Ostrea strigilecula, White	
		Camptonectes, indistinct, like *C. extenuatus*, Whitf.	Jurassic.
		Pectenoid shell, like *Entolium*, but probably new genus, possibly a Syncyclonema.	
		P. meleagrinella curta, M. & H., sp	
		Tancredia?	
		Pentacrinites asteriscus, M. & H	

APPENDIX B.—ERUPTIVE ROCKS.

By Waldemar Lindgren.

Engaged as assistant geologist to the Northern Transcontinental Survey early in the summer of 1883, I was a assigned to the party of Mr. W. M. Davis, sent out to study the lower strata of Paleozoic and Mesozoic age and their relation to the coal-bearing series on the eastern slope of the Rocky mountains in Montana. The eruptive rocks in the districts traversed being of great interest and importance, I found time and opportunity to give some attention to them. The field-notes relating to them, accompanied by the results of the microscopal and chemical examinations, are added here as an appendix to Mr. Davis's report on the general stratigraphy and paleontology. To Mr. Davis I am greatly indebted for many valuable field-notes. The short time at my disposal and the great diversity of rocks may perhaps be an excuse for the often incomplete and cursory character of the examinations.

At first a few remarks on the general topography and geology:

Topography.—The Rocky mountains occupy the western part of Montana, with a general trend to the b northwest, or somewhat more to the north; the eastern slope runs between longitude 109° W. (Clark's Fork mountains) and 114° W., where the chain crosses the frontier of British Columbia. In their southern and middle parts, however, they do not form a continuous range or straight line of uplift, but are broken up in many detached mountain groups, separated by the numerous rivers which have their headwaters in this region. Thus, the main divide between the Pacific and gulf of Mexico does not run parallel to the eastern slope of the mountains; it crosses the Idaho boundary line at 114° W. again, but runs very irregularly in the southern part of its course.

In the south, toward the Wyoming boundary-line, the Snow mountains and Clark's Fork mountains rise to from 10,000 to 11,000 feet of altitude. Pryor and Big Horn mountains stretch far out eastward and branch off into Wyoming. The lower ranges of the Snow mountains cross the Yellowstone river at its sharp bend southward c from the pass of Spring or Rocky cañon, through which the Northern Pacific railroad runs, and now trend northward as the well-defined Bridger range, the divide between the Yellowstone and Gallatin rivers. In front of the Bridger range, and separated from it by the broad Shields River valley, stands the rugged group of Crazy mountains, with their peaks 10,000 feet high, and which continue northward in the lower Elk mountains. Westward lies the fertile and extensive Gallatin valley, with the three forks of the Missouri and the lower ranges across the river; southward, a long and glittering sky-line of snowy peaks toward the Idaho line.

The Bridger range is continued northward in the mountains of Sixteen-Mile creek, and these in their turn by the Big Belt range (maximum altitude about 10,000 feet), which at last flattens and disappears above the easterly bend of the Missouri. East of the Big Belt, and not very distinctly separated from it, we have the Little Belt range, stretching out for 50 miles, sloping down northward toward the great plains south of the Missouri d and connecting in the south with the Elk mountains. In front of the Little Belt range there are the isolated masses of the Big Snowy, Judith, and Moccasin mountains; north of the Missouri, again, the lonely group of the Bear-paw mountains.

From the bend of the Missouri, from a northerly to an easterly course, however, the character changes; the outlying sentinel mountain groups disappear, and instead we have one continuous chain, at the same time forming the main divide, rising boldly and abruptly from the great plains. This main range runs far north into British Columbia, with a general trend of north-northwest; its peaks and summits toward the British frontier are covered by snow- and ice-fields.

General geology.—It is difficult to sketch, in brief outlines, the complicated and diverse geology of Montana, especially as our knowledge of it still is in a very imperfect and rudimentary state. What we know about it, up e to the present time, is chiefly due to the explorations of Messrs. Hayden and Peale, and this knowledge is mainly confined to the southern and eastern portion of the mountains. Of the northern and western parts only a few dominant and general features are yet discovered. The geological maps of Montana, published in the reports of the survey of the territories, only indicate the structure in a very general manner, and parts of them are exceedingly incorrect. The time to construct an approximately accurate map has certainly not yet arrived.

As everywhere on the eastern slope of the Rocky mountains, we find in Montana a perfectly conformable series, extending from the Cambrian, resting upon unconformable Laurentian gneiss, up to the Cretaceous, including the much-disputed upper member of that group, the Laramie. Near, and in, the mountains, presumably close to the old shoreline, the Cretaceous and Laramie attain an enormous development.

It must be remembered that Mr. Hayden's Eocene is equivalent to the Laramie or coal-bearing formation. f

From the plains in front of the mountains where, in a few places, the Laramie is exposed, with a thickness of 8,000 to 9,000 feet, it can be directly traced up toward the mountains. The sediments there growing coarser and thicker, and very poor in fossils, it naturally becomes difficult to recognize and trace the subdivisions in the Cretaceous group elsewhere established.

Far out in the plains we notice the first slight disturbances in the Cretaceous. As we come nearer to the mountains they grow larger and more pronounced, till they finally appear as those enormous synclinals and anticlinals, now deeply eroded and cut, which constitute the predominant feature of the mountains. Often the larger folds are suddenly cut off and faulted, showing the lower strata in direct contact with the younger Cretaceous.

a The Carboniferous limestone is laid bare by erosion on a large scale, and the task of the geologist to trace this great limestone sheet, with its complicated wrinkles and folds, is not always an easy one.

The Big Horn, Pryor, and Clark's Forks mountains are all more or less clearly anticlinal uplifts. The latter group, as far as our knowledge of it goes, is considerably faulted toward the northern edge, and the center occupied by older slates, Azoic rocks, and granite.

The sheet of Carboniferous limestone, with Jurassic and Cretaceous strata above, forms a portion of the foothills of the Snowy mountains, crosses the Yellowstone above Livingstone, and runs northward, forming the well-pronounced Bridger range, here having changed to a nearly vertical position. The valleys on both sides are occupied by Laramie layers. Northward again the limestone flattens, forming the great synclinal of Sixteen-Mile creek, with the Cretaceous in the middle of the basin, swelling up westward to the remarkable anticlinal of the **b** Three Forks of the Missouri, rising also northward and mantling the southern end of the gigantic, compressed anticlinal of Big Belt mountains, composed of Cambrian slates. North of Diamond City this anticlinal submerges again under the now slightly-inclined limestones of the lower Missouri and Smith's River cañon.

Somewhat north of the great bend of the Missouri the limestones sink in their turn under the Cretaceous strata of the great plains. The broad valley of the Missouri, between the two cañons, is now filled with the deposits of a quaternary lake.

Topographically and geologically closely connected with the Big Belt is the Little Belt range. Generally speaking it is an anticlinal uplift. Northward, around the Barker mining district, the sheet of Carboniferous appears soon to sink as usual with gentle dip under the Mesozoic strata of the plains. The interior seems much faulted, and to great extent made up of Silurian sandstones; even the Laurentian gneisses are exposed at one place. **c** Andesitic eruptions play an important part on the northern slope, and probably, also, on the southern; the far extending eastern slope is little known, but presumably also has the Carboniferous and Jurassic strata exposed along the border.

The free-standing groups of the Judith, Moccasin, Bear-paw, and Big Snowy mountains are all anticlinals, generally dome-shaped elevations. The latter, opposite the Little Belt, is broken on its southern edge by a fault-line, bringing the Laramie in contact with the Carboniferous.

The isolated groups of the Highwood and the Crazy mountains are of partially volcanic origin.

From the point, though, where the Missouri leaves its limestone cañon and changes its northerly course to northeast, making a bend of about 100°, we notice a most marked change in the geological structure. In traveling toward the now sharply-defined main range, the Cretaceous strata are seen steadily dipping to the west, and cut **d** by numerous dikes of younger eruptive rocks. At the base of the mountains we find a large fault, bringing up, Cambrian slates, and sometimes a zone of Carboniferous limestone on a level with the late Cretaceous deposits. This remarkable and long fault-line has been found by Mr. Dawson in British Columbia, by Mr. Pumpelly at Marias pass, and by our party at Cadotte's pass.

ERUPTIVE ROCKS FROM LITTLE BELT MOUNTAINS.

(Hornblende dacites and mica-augite-trachytes.)

The interior part of Little Belt around the sources of Belt creek is extensively covered by Silurian sandstone **e** equivalent to the Potsdam sandstone. This at Neihart is seen unconformably covering the Laurentian gneisses; the gneiss is traversed by a number of granite dikes, with coarse structure and flesh-colored feldspar. I have nowhere seen these dikes extend up into the overlying Silurian sandstone, and their age must consequently be fixed as pre-Silurian. Small fissure veins with silver ores traverse the gneiss and the sandstone.

Following Belt creek down some miles northward we come to a beautiful plateau or park, formed by this same sandstone, in which the creek has cut a cañon 500 feet deep with steep sides. The west side of the park is bordered by Tillinghast creek, flowing into Belt creek some miles farther down.

The Paleozoic limestone appears here again on a grand scale. It forms the mountains west, north, and east of the park, covering the country as a 3,000-foot, heavy, slightly inclined sheet, in which the creeks have cut down deep cañons with abrupt, fortress-like walls.

f This region is characterized by numerous and large eruptions of a quartziferous hornblende-andesite or hornblende-dacite. The dacite breaks through Carboniferous limestone, and appears, not as dikes, but as large, compact bodies, pushing up and disturbing the immediately surrounding strata. Dikes of dacite probably appear besides these massive eruptions, although I did not succeed in finding any.

The first great massive is the mountain closely west of Tillinghast creek. Seen from the Park it looks like a long, broad elevation, rising about 100 feet above the creek. The mass is 2 miles long, and perhaps 1 mile broad. The contacts are well exposed, and show very clearly how the eruption affected the surrounding Carboniferous and lower limestone; the whole can be compared with nothing but an enormous "plug" driven up through the sediments. It does not disturb the sedimentary rocks to a great extent; its only action has generally been to turn up, perhaps even reverse, the edges of the surrounding, generally nearly horizontal, strata for a distance of one thousand or two thousand feet.

Close to one contact on the eastern side a black, somewhat metamorphosed Silurian (?) slate was seen dipping 15° *toward* the eruptive; actual contact not seen.

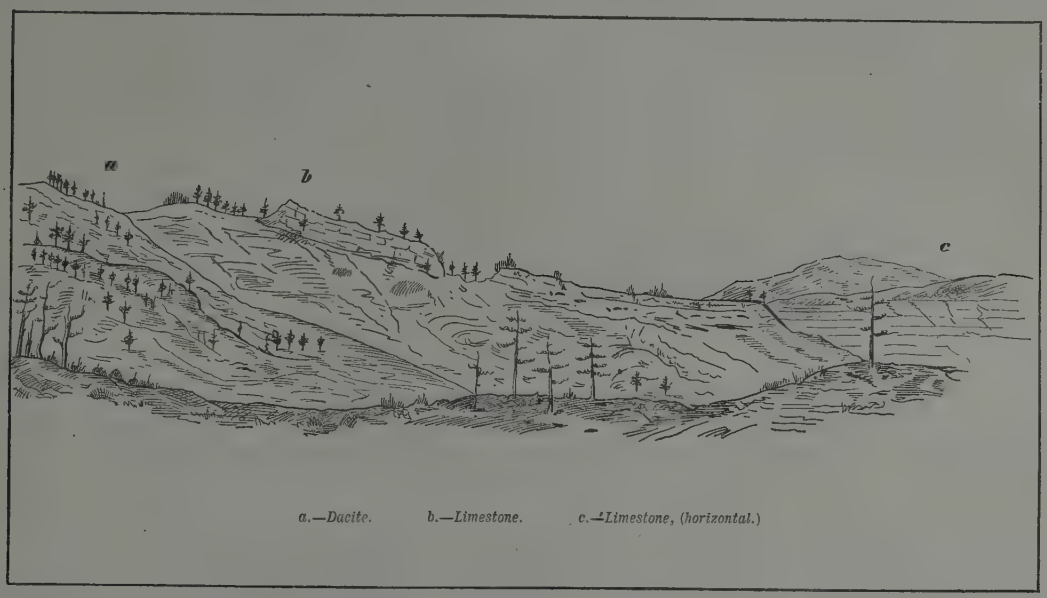


FIG. 240.—CONTACT OF HORNBLENDE-DACITE AND CARBONIFEROUS LIMESTONES. TILLINGHAST CREEK, LITTLE BELT MOUNTAINS, MONTANA.

Contact at southern end 590 feet above the creek (Fig. 241): At the contact very steep-dipping limestone, decomposed where it touches the also decomposed eruptive; in a few hundred feet distance the dip has flattened out again.

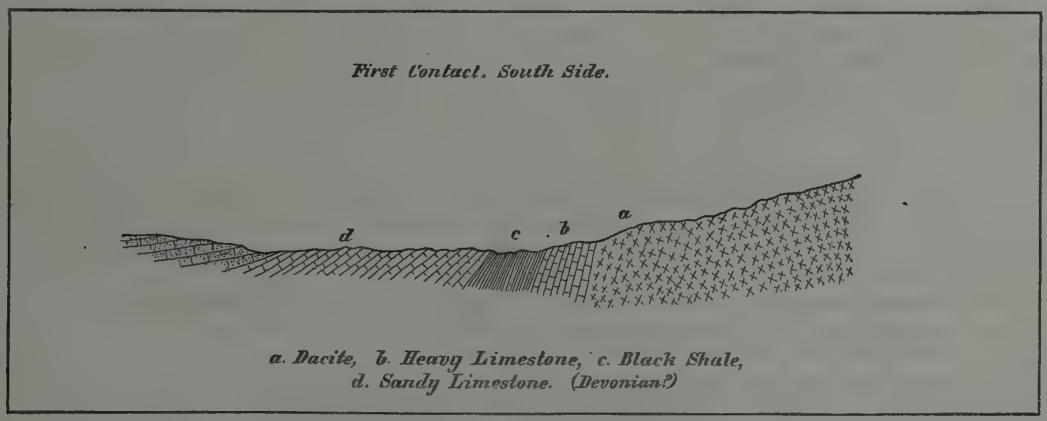
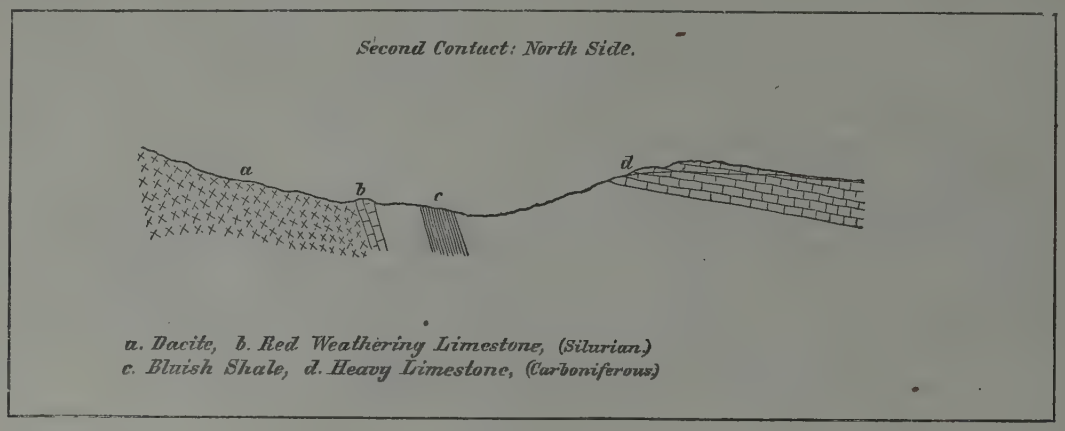


FIG. 241.

Contact at northern end (Fig. 242): Actual contact not seen; near it, however, a steep-dipping, red-weathered Silurian (?) limestone and conglomerate; a few hundred feet from this place only a slight dip northward shown by the heavy Carboniferous limestone. Fig. 240 is a view at the north end showing the beautiful curved form of a heavy limestone bench near the eruptive. Nowhere are there signs of intrusive sheets or overflows. The whole is doubtlessly very much eroded, and we have here only the nucleus—the lower interior part of a perhaps originally far more extensive eruption. As to its age, the strata here only give evidence of its being post-Carboniferous; there is, however, abundant proof—beside the microscopic diagnosis—for pronouncing the eruptive of a Laramie or later age. (See beyond under Highwood mountains and Dearborn district.)

a Farther west, beyond this eruptive, there seems to be others of the same character, but the time did not allow our exploring of that region. At Belt creek, on the other side of the Park, a similar rock, but quartz free, consequently hornblende-andesite, was found loose; the dike or massive from which the pieces have come could not be found.



b

c

FIG. 242.

A dike of apparently typical mica-augite minette crosses Belt creek about 6 miles below the mining town of Barker, and protrudes like a sheet in the ravine leading down to the creek.

Hornblende-dacite.—(1) Tillinghast eruptive. Yellowish-gray color; porphyritic habitus. Crystals of a glassy feldspar, and a smaller variety of a yellow color. Throughout the mass, evenly but not copiously distributed, brown mica and hornblende needles 1 to 2^{mm} long and 0.2^{mm} thick; a few small quartz crystals; all embedded in a d grayish groundmass. The quantity of hornblende and mica varies somewhat, and occasionally, in some parts of the eruptive, goes so high as to impart a greenish color to the specimen. Sometimes the glassy feldspar is absent.

Thin section: In a grey groundmass are embedded sanidine; few, but larger, fresh crystals, mostly rounded, showing the cracked surface and zonar extinction of the sanidine; these are the glassy feldspars. In order to prove them conclusively as sanidines a small portion was isolated, powdered, and the angles of extinction in the faces of O P and ∞ P $\breve{\infty}$, measured on the thus-formed microscopic cleavage. They were found to be 0° or 5° to 6°, consequently corresponding to sanidine.

Plagioclase is the predominating feldspar; general form, short rectangular or prismatic; striation, very narrow; often two systems crossing each other; colors of polarization, dull grayish. Angle of extinction between two adjacent, hemitropic bands in zone perpendicular to ∞ P $\breve{\infty}$, measured up to 34°, or 17°+17°. This feldspar is e consequently most probably *oligoclase.*

In some sections besides this there also occurs a small number of another kind of plagioclase, presumably more approaching the labradorite. Long rectangular form, always very decomposed, and always, at usual thickness of section, shows the colors of polarization—light brown, deep blue. Polysynthetic twin structure often missing; when occurring, very fine.

Quartz in irregular, rounded grain, clear as usual, and carrying a great number of fluid inclusions with moving bubbles, and also gas-pores. Glass inclusions rare. As to the quartz and its relation to the groundmass, see farther down. The mica is brownish-green, very fresh, with strong absorption. Hornblende often very decomposed into viridite and filled with opacite; when fresh with splendid cleavage and not very strong absorption: $c > b > a$; c, grayish brown; b, yellowish brown; a, yellowish green. In some sections hornblende, in others mica, is prevailing. f Augite occurs in two sections sparingly, in small, light green, fresh prisms. Apatite, with its usual characteristics, is also sometimes present.

All these minerals are imbedded in a micro- to crypto-crystalline groundmass of quartz and feldspar; sometimes it is almost impossible, even with high power, to resolve it; sometimes it appears already under No. 4 Hartnack as a clear micro-crystalline aggregate. Between the single grains some very small remains of glass may occasionally be observed. This variety of dacite is to be referred to Doelters "porphyritic dacites" in his classification of the Hungarian rocks. In all of the specimens quartz is largely represented, and always has a tendency to granophyric structure.

I do not know that this structure has been noticed before in dacites. In some sections the quartz-grains appear, so to speak, crushed, all the fragments being perfectly parallel in their optical orientation. The intervening space is filled by feldspar. From this we notice transition down to a complete granophyric structure of the

groundmass. The groundmass contains a network of quartz, with included feldspar, and is divided into irregular **a** portions, in which the quartz crystals extinguish simultaneously. In one section all of the larger quartz crystals have the same structure.

A determination of SiO_2 in one variety, rather rich in hornblende, gave $SiO_2 = 64$ per cent.

The age of this dacite is sufficiently proved by the occurrence of precisely the same rock in Laramie conglomerate of Highwood mountains, and as dikes in Laramie strata near the main range.

In Little Belt, this type is furthermore represented by a large massive eruption, 3 miles north of Dry fork of Belt creek, near the Summit stage-station, on the road from Barker to Fort Benton. It here cuts through the edge of the Carboniferous limestone just before it disappears under the flat, Mesozoic strata of the plains and shows, only not quite so clearly, disturbances at the contact analogous to what we already have described from the **b** Tillinghast eruptive.

Another type is the above-mentioned rock found loose on the slope of the hills near Belt creek. Macroscopically a greenish gray, fine granular substance, showing thin hornblende crystals in a white feldspar groundmass.

Thin section.—Long crystals of the common, green hornblende, few biotites and rare quartz grains in a perfectly crystalline mass of plagioclase, sometimes with prismatic outlines. Sometimes, however, glass remains are pressed in between the crystals. This variety would seem to approach, in Mr. Doelter's classification, the granitophyric dacites.

Mica-augite-trachyte dike on Belt creek (appearance of a mica-minette).—Dull, brownish-gray colored rock, weathering brown, an apparently homogeneous groundmass with numerous, imbedded biotites and occasionally a **c** reddish, imperfectly-defined feldspar crystal. Rather porous; the cavities occupied by small amygdaloid nodules or secondary quartz. Upon closer inspection it appears that the uniform gray groundmass gives a slight reflection as if from large cleavage faces.

Thin section: A perfectly crystalline rock of irregular, large feldspar individuals; no groundmass or perceptible glass between the crystals; these are generally cracked and show absolutely no polysynthetic twin structure, the general characteristics pointing decidedly toward orthoclase. As no good optical measurements could be obtained, some powder of the crystals was submitted to microscopical test. The thin laminæ parallel to $\infty P \grave{\infty}$ always show an extinction of 5° to 6°, counting from the edge $0 P, \infty P \grave{\infty}$. The feldspar is consequently orthoclase (sanidine). A cloud of microlites of the substances mentioned below fills parts of the feldspars, making them appear opaque; other parts are clear; little or no decomposition. **d**

Quartz in small quantity, probably secondary, sometimes fills a space between feldspar crystals.

Next to the orthoclase, the biotite is the most important mineral; it occurs in larger sheets, down to the smallest microlites, always as an inclusion in the feldspar.

The isolated hornblende is very doubtful, being much decomposed, and filled with apatite.

Much more common is a clear, light-green augite, also embedded in the feldspar in irregular granules or small prisms. There is about as much augite as mica, and it also goes down to the smallest dimensions.

No titanite; some apatite and magnetite throughout the mass. Thus, products of first consolidation, augite, brown mica, apatite, magnetite; second consolidation, orthoclase.

We have here a rock, consisting principally of orthoclase, mica, and augite, which, judging from macro- and microscopical diagnosis, most undoubtedly is to be referred to Mr. Rosenbusch's family of the mica-syenites or **e** minettes (*Mikr. Physiogr.*, p. 121), the large amount of augite making it approach the augite-syenites. From its geological position we can infer nothing more than a post-Carboniferous or rather post-Silurian age. Thus far there is nothing remarkable, but its relation to subsequently-described eruptives makes it more than probable that this typical minette of a decidedly old appearance in reality is a very young Tertiary rock, and younger than the large dacite eruption in the neighborhood.

The first evidence toward this conclusion comes from the study of a large dike near Otter creek, north end of Little Belt, 6 miles north of Barker. We are here east of the formerly-mentioned large limestone sheet, in a region of more marked disturbances. The strata swell up and form several anticlinals. On the western flank of such an anticlinal, in layers considerably above the Carboniferous, and doubtlessly of Jurassic age, the dike in question appears, forming a high ridge on the west side of the creek. In a snow-white mass of small feldspar granules or **f** crystals are imbedded a great number of biotite foils, perhaps 4^{mm} in maximum diameter. They do not lie parallel, but intersect the feldspar in all directions, thereby often obtaining an icicular appearance.

Thin section: An essentially crystalline mass of long rectangular, but also irregular, large feldspars. A few individuals are plagioclase, but the predominating number show all the characteristics of orthoclase; rather milky, filled with interpositions, but not decomposed; many Carlsbad twins. On account of the irregular form and absence of cleavage no reliable stauroscopic observations could be made, and it was found necessary to establish the species of feldspar conclusively by means of an alkali determination; and such was made in the laboratory of the survey by Mr. Whitfield and gave: $K_2O = 5.5$ per cent.; $Na_2O = 4.1$ per cent.

The alkali, contained in the biotite and the glass (see below), might influence these numbers, but considering that these constituents only make about 10 to 15 per cent. of the mass, it becomes evident that they would not change the result very notably. Making due allowance for the small quantity of plagioclase, we come to the conclusion that the feldspar in question is an orthoclase or sanidine, rich in Na_2O.

a Biotite, embedded in the feldspar as irregular sheets or bacillæ; very fresh, and showing strong absorption.

Augite, light grass-green, perfectly clear, no dichroism; mostly in form of irregular granules between the feldspar crystals, but not dispersed through them as microlithes.

Apatite, in long needles, traversing the feldspar. Small quantity of magnetite.

Thus, products of first consolidation, biotite, augite, apatite, and magnetite; of the second, sanidine (and plagioclase).

The generally triangular interstices between the feldspar crystals are filled by a clear, almost colorless glass without any interpositions, but occupying only a small part of the section. Sometimes it is seen filling the interior part of a prismatic feldspar crystal, making the impression of a corrosion of the sanidine in the yet liquid magma. b In a few places, with crossed nicols, faint bluish spots appear in the glass; this seems to be due to polarization by pressure.

Here again we have a biotite, augite, orthoclase rock, in which, however, the feldspar does not fill the space completely, but contains remains of glass. It bears decidedly the character of a younger rock, and must be referred to the mica-augite-trachytes, the younger equivalents of the mica augite-syenites. In discussing Highwood eruptives we shall find the augite-trachytes on a large scale again, and there they can be proved being of a post-Cretaceous age.

Their analogy, microscopically, with the pseudo-minette of Belt creek is so great that I have no hesitation in pronouncing both varieties to belong to one period of volcanic activity. Furthermore, the time between the Silurian c and Cretaceous periods was in the west of America comparatively quiet, and only disturbed by a few granitic eruptions in some places. Thus we have here an instance of a younger rock appearing to perfection like the corresponding "old" form.

This illustrates how unsatisfactory the prevalent division of eruptive rocks in pre- and post-Cretaceous really is.

HIGHWOOD MOUNTAINS.

The Highwood mountains form a completely isolated group, about 15 miles south of Fort Benton, occupying 14 miles from east to west and 12 miles from north to south. From their highest peaks the great plains of the upper Missouri may be seen extending, arid and brown, in all directions; southward the hills of the Little Belt mountains break the monotony of the horizon, and in clear weather the snowy peaks of the Main range are d visible toward the west.

The slightly inclined Carboniferous limestone of the northern Belt mountains dip, as one proceeds northward, under Triassic and Jurassic strata, which in their turn are covered by flat Cretaceous strata, here forming the surface of the great plains and gently sloping down toward the Missouri. Standing on a plateau of an average altitude of 4,000 feet, the mountains attain a maximum height of 7,600 feet. Their base is covered by a scant vegetation, above which the higher ridges, sometimes wonderfully serrated, stand out brown and barren.

The Highwood mountains are mentioned in Dr. Hayden's *Final Report on the Exploration of the Upper Missouri and Yellowstone*, 1872. Dr. Hayden remarks having seen from the road from Fort Benton to Judith basin some sharp peaks, indicating volcanic origin to the south or southwest. He undoubtedly refers to the Highwood e mountains. On the map accompanying Hayden's report they are marked as an anticlinal with Carboniferous and older strata, none of which could be found at the time of our visit.

The strata extending close up to the first hills are almost horizontal, and can be identified as the Fort Benton black slate (Cretaceous No. 2), which also appears, according to Hayden, on the north and west side of the mountains. Approaching the slopes isolated volcanic dikes are encountered; they increase in number as one advances, and finally form a complete network; the sedimentary rocks included between them are highly metamorphosed and hardened, often more or less disturbed, but, perhaps, as frequently retaining their horizontal position; the highest parts of the mountains are often formed of these horizontal and hardened strata. Nowhere were any evidences found of the upheaval of any rocks older than the Cretaceous.

To explain the genesis of this remarkable group, it must be borne in mind that nowhere in the surrounding f country are any strata higher than Cretaceous No. 2 found. The question naturally arises, why the rest of the marine Cretaceous (about 1,000 feet) and the enormous Laramie deposits (8,000 feet on the plains and over 20,000 feet near the mountains in Montana) are not represented—and the answer is, that they once did cover the plains and that the 4,000 feet of the Highwoods are the only remaining remnant of the heavy sheet.

Since the end of the Tertiary era the untiring erosion has cut away thousands of feet of sediments, but the dikes and the metamorphosed strata of a Tertiary volcanic district resisted the destructive power far more than the softer sandstones and shales, and thus the Highwoods have been chiseled out and left standing alone as a monument of volcanic force. We have laid bare to our eyes the nucleus, the inbound structure of a Tertiary volcano or group of volcanoes.

Thus far only dikes, but no intrusions or laccolites, have been found. That such eruptive forms may exist, however, is quite probable.

The Highwoods do not stand alone in America as a type for this peculiar form of mountains resulting a from the combined effect of volcanic and erosive agencies; the Spanish peaks in Colorado, for instance, evidently belong to the same class—nor do they stand alone in Montana. The beautiful group of the Crazy mountains north of the Northern Pacific railroad are, according to Mr. J. E. Wolff, essentially similar; also, the Birdtail mountains west of the Highwoods, near the main range, on the road from Helena to Fort Benton.

The dike eruptives of the Highwoods subdivide into two clearly distinguished but intimately connected groups, *trachytes* and *basalts;* the former are nearly all augite-trachytes, the latter andesite (noseane) basalts. They consequently belong to a class of volcanic rocks, which, in America, has generally been regarded as late Tertiary, and there is indeed in their occurrence nothing to contradict such a supposition. They certainly traverse strata, much higher than the Cretaceous, and on the other side they manifestly date before or shortly after the beginning b of the erosion. Of the two groups the basaltic seems the older; only one intersection, however, was noted, a trachytic, highly feldspathic dike cutting a dark basaltic one.

Before entering on the discussion of the dike eruptives a brief mention may be made of a remarkable volcanic conglomerate, apparently forming a part of the strata surrounding the dikes and occurring about 1 mile east of the road across Highwood gap, about 5 miles south of the divide. It is interesting because the pebbles are composed only of dacite and hornblende andesite, probably derived from once existing now obliterated massives, similar to those of Little Belt mountains. The position of this conglomerate can not be more than 1,000 feet above cretaceous No. 2, exposed at the foot of the mountains; that is, it must be placed in the Lower Laramie. That the andesitic eruptions in Montana began in the later Cretaceous period or in earliest Laramie, is an inference to be drawn from this occurrence and confirmed by other facts to be mentioned later. c

The pebbles are rather large, up to 10^{cm} in diameter, and are composed of hard grayish or brownish porphyritic rocks; in a brown or light-gray groundmass are imbedded small hornblende prisms and a great number of white feldspar crystals, generally less than 2^{mm} long. A few larger feldspars resemble orthoclase.

Thin section.—The feldspar appears predominatingly as plagioclase, while some supposed to be orthoclase could not be distinctly proved as such. The same two varieties of the plagioclase mentioned in the discription of the Little Belt dacites, we meet here again: (1st) Short, prismatic crystals, with polysynthetic striation, dull colors of polarization and symmetrical extinctions indicating oligoclase. (2d) Longer, prismatic crystals with no or few polysynthetic bands and dark blue—light-brown colors of polarization.

Quartz does not occur as larger porphyritic crystals, but is common in the groundmass of some slides.

Green hornblende crystals and a few foils of brown mica are to be observed. d

The groundmass is in some varieties clearly micro-crystalline, composed of feldspar and quartz; in others, crypto-crystalline; in others again, glassy, with sometimes micro-fluidally arranged plagioclase microlites, and without quartz.

There is a great similarity between these rocks and the dacites of Little Belt and Dearborn districts, and I feel but little hesitation in classifying them as hornblende dacites and hornblende andesites, and belonging to the same time of eruption.

Trachytes.—The trachytic rocks are quite abundantly represented, and of a great variety of appearance. Only one instance of a pure sanidine rock, or sanidinite, has been found. Augite, or sometimes biotite, but as far as observed, hornblende never enters. From varieties poor in these constituents, but rich in feldspar (orthoclase and oligoclase), the series runs down to dark, heavy rocks, composed of equal quantities of augite and sanidine, or with predominating augite. The biotite never holds such a prominent place, but in most cases accompanies the e augite. Sometimes, but seldom, the olivine appears.

The occurrence of such a variety of undoubted trachytes in the United States is in itself quite remarkable. Very few, I believe, of the supposed trachytes of the Fortieth Parallel have borne the test of renewed examination, and it appeared as if this group of Tertiary eruptives were compartively rare in America. Future examinations will, I think, discover quite large trachytic districts in Montana.

The occurrence, on the other hand, of such large quantities of augite entering in the composition of these rocks is quite unusual; so much so, in fact, that Rosenbusch (*Mass. Gest.*, p. 179), after giving the definition of trachyte, makes the following important restriction: "The quantity of the micaceous, augitic, or hornblendic constituents is always limited, and not even microscopically prominent (auffallend)." On page 200, while discussing f the difficulty of classifying the trachytes, Rosenbusch refers to the probability that eventually trachytes richer in mica or bisilicates may be found, which would allow the establishment of subdivisions running parallel with those of the syenites.

It seems, indeed, as if here such a subdivision had been found, *i. e.*, that corresponding to the augite syenites.

The rocks may conveniently be described in the following order: (1) Sanidinite; (2) augite (biotite) trachytes. Equivalents: Augite syenite. (*a*) coarse granular; (*b*) porphyritic, groundmass mainly feldspathic; (*c*) porphyritic, groundmass augitic, glassy.

(1) *Sanidinite.*—A dike of about 50 feet thick of this rock was found in the southern foot-hills, near the road to Fort Benton. A yellowish-gray, somewhat porous and rough rock, with large (1 to 2^{cm}) yellowish, cracked sanidine crystals. An alkali determination of the rock, made by Dr. Gooch, gave, Ka_2O : 11.82 per cent.; Na_2O : 2.5 per

a cent.; consequently an almost pure sanidine rock. *Thin section:* Large sanidine crystals, of thick, lamellar habitus, in a groundmass of smaller sanidines; much limonite in the groundmass; no plagioclase observed; trace of isotropic glass; biotite isolated.

(2) *Augite-trachytes* (often with biotite).—(1) *Crystalline:* On both slopes of the Highwood mountains we find a light colored, predominantly-feldspathic rock closely related to the one just described. Light gray or yellow, coarsely crystalline; cleavage planes of the feldspar up to 8^{mm} long; no porphyritic or well-developed crystals. Augite in small grains, sparingly; very few biotites.

Thin section: Small, irregular green, augite grains, as before, imbedded in a perfectly crystalline mass of feldspar individuals, irregular or prismatic with broken ends.

There are probably three feldspar varieties: (1) Orthoclase (sanidine) irregular granules with bluish-gray
b colors of polarization. (2) The large prismatic individuals which seldom, if ever, show polysynthetic structure; only exceptionally a few very thin bands were noticed. Colors of polarization grayish brown, deep blue. It is undoubtedly plagioclase, but of what variety I am unable to say. (3) Small quantities of another plagioclase (oligoclase) with exceedingly fine striation, often grown into and curiously interlaced with the sanidine.

Decisive optical measurements being impossible, an alkali determination was kindly made by Dr. Gooch, and gave $Na_2O=7.88$ per cent., $K_2O=5.66$ per cent. An oligoclase with such a quantity of potash can hardly be assumed, while on the other hand the sanidine may contain a considerable quantity of soda; this in connection with the optical observations will render the assumption probable that here are present about equal quantities of sanidine and plagioclase.

The perfectly crystalline development and the total absence of any basis or groundmass is remarkable.

c (*b*) *Porphyritic feldspathic groundmass.*—On the northern side, a few miles from the divide, a heavy trachyte dike intersects the road to Fort Benton. Here the augite begins to appear in more prominent quantities.

Greenish-gray fine-grained rock, porphyritic by a large quantity of parallel, thin lamellar, white sanidine crystals (maximum, $5.10^{mm} \times 1^{mm}$). In the groundmass numerous small feldspar grains; dark green, often perfectly developed augite crystals up to 3^{mm} long, and numerous small biotites. The sanidine crystals were determined as such by the method of Boricky, and also by an alkali determination by Dr. Gooch, which gave $K_2O=11.36$ per cent., $Na_2O=$ 2.14 per cent.

Thin section: The groundmass is fine-grained, and composed of sanidine, augite, and biotite with traces of glass; further opacite and a few small, clear apatites, proved as such by micro-chemical tests.

The feldspar microlites are undoubtedly of the same nature as the larger crystals, and in fact a gradual transi-
d tion from the porphyritic down to the smallest individuals can be noted; the sanidine is generally lamellar and elongated in the direction of the clino axis; somewhat opaque so that no accurate measurements can be made.

Biotite appears frequently as small fresh-brown laminæ from 1^{mm} down to microlitic dimensions. The occurrence of mica as constituting part of a trachytic groundmass is to be noted as something very unusual.

The augite is the same variety, which we find in *all* Highwood dike eruptives, trachytes, or basalts, and which seems also to be largely represented in other Tertiary eruptive districts of Montana. In this rock it appears both as perfect crystals and as irregular grains. The crystal form is generally long prismatic of the combination ∞ P. ∞ P $\breve{\infty}$. ∞ P $\breve{\infty}$. P. OP, the first three forms often equally developed. Color dark green, in thin section, clear grass-green; pleochroism very seldom appreciable, generally very fresh, showing great resistance to decomposition, Good prismatic cleavage. Twins, not observed macroscopically, are frequent in thin section, the twin plane.
e generally with some interposed hemitropic bands, cutting the direction of cleavage in prismatic crystals with an angle of about 19°. Beautiful zonar structure by inclusions of groundmass or by alternating darker and lighter zones is common. Extinction, maximum 40° to 45°. This important variety should be examined chemically.

The augite increases in the trachytes, now to be described, and the sanidine gradually disappears.

A specimen from the southern slope has the same structure as the one just mentioned, but the sanidines are much smaller (maximum, 3^{mm}) and thinner; as much augite as sanidine is present, appearing as porphyritic crystals and as grains in the groundmass. The main part of this is formed of short, milky feldspar microlites, doubtlessly also sanidine; isolated, somewhat doubtful plagioclase microlites. Small quantities of biotite, opacite, and apatite.

Another very similar specimen shows some glass in the groundmass; no plagioclase; all the short feldspar microlites appear with extinctions from 0° to 5°.

f Finally, in a series of specimens the porphyritic sanidine disappears and the augite takes its place in long, dark green, well-developed crystals; the groundmass is also dark-greenish or gray, and consists of larger augite grains in a maze of small, short microlites; a few polysynthetic plagioclases may be noticed. Generally, however, the extinction, when measurable, ranges from 0° to 5°. From this and from the shape of the microlites we must class them as sanidines.

It is not to be denied that a separation of the feldspars here would be very desirable in order to ascertain the percentage of plagioclase contained in the rock. The transition from larger sanidines to the microlites, however, can be so clearly noticed that but little doubt as to the nature of the latter can be entertained.

Specimen No. 42 is a dark-green rock, in which with the naked eye only the larger porphyritic augite crystals can be distinguished.

Thin section: Larger and smaller augites in a sanidine groundmass with doubtful glass remains; rather much **a** opacite and hematite. It appears as if these opacites resulted from originally-formed but later destroyed hornblende crystals. Few biotites.

Specimen No. 41 is similar, and shows augite crystals up to 4 to 5^{mm} long. Groundmass composed of short, clear sanidines, slightly reddish from fine hematite dust; larger augites and small quantities of biotite and opacite.

In two specimens of this highly augitic trachyte has olivine been noticed. One, from Highwood mountains, is perfectly similar to the varieties just described; carries large augite with beautiful zonar structure, besides biotite, magnetite, and small olivine crystals with a yellow fringe. Sanidine groundmass, with some glass as usual. The other, closely related to the Highwood rocks, is found by Professor Pumpelly near the head of the Musselshell river, 80 to 100 miles south of the Highwood. Macroscopically, a grayish-green rock with porphyritic long (maximum, 10^{mm}) and slender augite prisms, in a groundmass of augite, biotite, and a white mineral. **b**

Thin section: The common Highwood augite in larger and smaller crystals, here more decomposed than usual to chloritic products; in the Highwood rocks the augite is almost always perfectly fresh. Few fresh olivines, rather much biotite, some opacite, and an exceptionally large quantity of apatite, proved as such by microchemical tests.

The groundmass is composed of a network of larger and shorter feldspar microlites, with some glass. Undoubtedly much sanidine (extinction, 0° to 5°), but also considerable quantities of plagioclase. It seems rather doubtful where this rock should be referred. In spite of its basaltic constitution it certainly belongs to the natural group of the Highwood trachytes. Pure, unquestionable *plagioclase basalts*, belonging to the same eruptive epoch and with the same augite variety, do exist in Montana, in the Birdtail mountains, west of Highwood mountains.

It now only remains to describe the last subdivision (c), that of porphyritic augite-trachytes with augitic, glassy **c** groundmass.

Specimen No. 10, found on the southwest slope, appears as a dense dark green or greenish gray groundmass in which are embedded lamellar, thin, and perfect sanidine crystals, clear or slightly reddish; no parallel distribution of the porphyritic crystals is noted; maximum size, 3^{mm} long and broad by $\frac{1}{2}^{mm}$ thick.

In thin section the large feldspars are perfectly fresh and clear, beautifully contrasting with the green groundmass. Generally appearing as Carlsbad twins and showing all the characteristics of sanidine. Longer individuals are crossed by irregular cracks; zonar extinction is common; thin sections about perpendicular to ∞ P $\bar{\infty}$ extinguish parallel to the edges; on broad crystals, cut approximately parallel to ∞ P $\bar{\infty}$ the angle OP. ∞ P $\bar{\infty}$ was measured to 116°. One axis of elasticity makes an angle of 5° with the clinoaxis. Farther embedded **d** in the groundmass, and sometimes in the sanidine, are smaller, irregular, slightly dichroitic *augite* grains (grass-green to olive-green), and a small number rounded or hexagonal isotrop sections clear or slightly brownish. Taking into consideration the results obtained from the basalts, they must be regarded as *nosean* or *analcite*.

Under immersion objectives the homogeneous groundmass is resolved, and shows a colorless glass in which are embedded numberless, thin augite needles, often with beautiful microfluidal structure. There is a series of specimens very similar to these trachytes, but generally more or less decomposed. The larger augite grains occur sparingly and show a peculiar bacillar structure. The microlites of the groundmass extinguish here with an angle of 10° to 20° and appear to have been changed to hornblende; the glass basis shows irregular faintly polarizing spots.

That this group of trachytes is not limited to the Highwood mountains is proved by a specimen collected by Mr. G. H. Eldridge in the Judith mountains about 80 miles southeast from the former. It shows large and perfect **e** (up to 3^{cm} long) reddish sanidines prismatically elongated parallel to the clinoaxis embedded in a green, dense groundmass, which, hastily examined, appears very decomposed and consisting of much *viridite*, small feldspar microlites, and some glass.

Analcite (nosean) basalts.—The second, and perhaps the larger, group of the Highwood dike eruptives, is composed of these remarkable rocks. Their constituents now are augite, olivine (biotite, magnetite, apatite in subordinate quantities), and analcite—absolutely no plagioclase, leucite, or nepheline can be found. It is probable that the analcite has resulted from the decomposition or the molecular change of a primary nosean. It cannot be denied, however, that there is much in the microscopical appearance which only with difficulty can be explained by this supposition, and often the appearance would lead the observer to regard the analcite as a primary mineral. The presence of pure nosean has, indeed, not been proved, but a small quantity of sulphuric acid, always present **f** in these rocks, together with other facts, renders it very probable that this mineral was in reality the primary.

The basalts appear as dark-green to greenish-gray rocks, with porphyritic augite crystals up to 10^{mm} long, generally presenting the combination ∞P. ∞P $\bar{\infty}$. ∞P $\bar{\infty}$. 0P. P. The mass containing the augites is generally fine grained and consisting of augite-grains, brown olivines up to 0.5^{mm}, and round or hexagonal white crystals of analcite (nosean) up to 1^{mm}. Mica is not generally seen macroscopically. The fresh rock is often exceedingly hard and compact. Specific gravity 2.4 to 2.6. When decomposed, the basalts become soft and brown, cavities are formed and filled mainly with stilbite.

In thin section the general aspect of the rocks is that of larger augite- and olvine-crystals and clusters of augite, biotite, and opacite microlites, embedded in a white mineral which sometimes simply appears as a groundmass, but more generally also is distinctly crystallized as a number of rounded, hexagonal, seldom octagonal,

a sections, ranging from 1mm to 0.1mm, with sharp outlines, or dissolving into the general groundmass. In short, the mineral in question behaves as does the leucite in the leucite-basalts. Very fine grain, however, such as is seen in many of these has not been observed here. Generally objectives 2–4 are fully sufficient. This white groundmass and these crystals now consist mainly or exclusively of analcite.

The first variety examined is apparently perfectly fresh fine-grained rock in which the small white crystals can be clearly seen with the naked eye. In thin section the white mineral forms numerous rounded or hexagonal individuals and a small amount of groundmass. It is clear and nearly colorless, only slightly brownish as from finely-divided dust—no inclusions of zonally or otherwise arranged microlites in the crystals; no cleavage; only in a few places is the mineral slightly milky and opaque. Between crossed nicols, perfectly isotropic only with an occasional bluish b spot often coinciding with the milky portions. In very few places decomposing to an aggregate of desmine needles—the other constituents, and especially the *olivine*, are perfectly fresh and intact.

The mineral was separated by means of the solution of Thoulet and analyzed. Specific gravity, 2.2. Dissolves easily in HCl, SiO_2, separated as slimy powder.

c

	Highwood.	Analcite from Kaiserstuhl (Weltzien).(a)
	Per cent.	*Per cent.*
SiO_2	54.90	54.02
Al_2O_3	23.30	22.54
Fe_2O_3	Trace.	1.35
CaO	1.90	2.91
MgO	0.70	0.57
Na_2O	10.40	10.14
K_2O	1.60	0.71
H_2O	7.50	8.93
	100.30	101.17

a See Dana's Mineralogy.

A small quantity of sulphuric acid is present, but was not determined; also trace of chlorine. The mineral d has unquestionably the composition of analcite.

The second basaltic variety is macroscopically quite similar to the first; the constituents of the groundmass are perhaps not quite so easily recognizable with the naked eye. In thin section, with reflected light, it again appears structurally quite similar to the first; in transmitted and polarized light the groundmass and the rounded crystals are observed to behave differently. They are generally white and milky as if decomposed, not uniformly so, however; irregular patches and spots are of ideal clearness and purity. No cleavage or interpositions can be noted in the crystals. Between crossed nicols peculiar phenomena of polarization are noticed, the clear parts often, not always, remain isotropic; the largely predominant milky parts are double refracting, and show dull, bluish-gray colors; neither the groundmass nor the crystals have an aggregate structure; every one of the latter is to be regarded as one individual. Most of them show irregular larger spots, alternately dark and light, when the stage is revolved, e but in a number, apparently where the section has a certain crystallographical orientation, a peculiar division of each crystal into triangular areas with their apex in the middle and alternately dark and light is seen. The most common is a division in 4 sectors, but in some I have observed 6 or 8. I know of no other of the here possible minerals but the analcite which presents such phenomena. Dr. A. Ben-Saude, while examining the optical properties of the analcite (*Neues Jahrbuch*, 1882), came to conclusions closely corresponding with the here observed facts. Some analcite varieties are quite isotropic; others, when cut in an arbitrary direction, present irregular alternatingly dark and light spots; cut parallel to a crystallographical surface he noted a division in triangular sectors, 4 when parallel with $\infty O \infty$, 8 when parallel with mO, and so on.

Here, too, a separation was effected, and the analcite (very impure from want of material) subjected to analysis. It contained—

f

	Per cent.
SiO_2	24.16
Al_2O_3	15.50
Fe_2O_3	2.10
CaO	2.12
MgO	2.42
Na_2O / K_2O	6.79
H_2O	4.50
Residue	41.00
Total	98.59

Small quantity of sulphuric acid noted but not determined; very little K; the separation of SiO_2 and insoluble a residue was made with KOH, and is consequently not to be regarded as very accurate.

Assuming that the Fe_2O_3 is present as hematite or magnetite, further subtracting a quantity of SiO_2 necessary to form Mg_2SiO_4 (dissolved olivine), we obtained, by recalculation—

	Per cent.
SiO_2	43.59
Al_2O_3	30.24
CaO	4.13
Na_2, K_2	13.26
H_2O	8.78
Total	100.00

b

This is a result such as may be expected from a decomposed nosean; the SiO_2 is too low for analcite (nosean has SiO_2 38 per cent.) and the Al_2O_3 is too high. That on the other hand pure analcite exists in the rock can be but little doubtful from the results of the optical examination; we may perhaps regard the white mineral as a mixture of some primary nosean and predominating secondary analcite.

The olivine and augite here, as in the first variety, are entirely fresh and clear.

The third variety is a dark-green rock of very fine grain, and with but few porphyritic augites. In thin section c fresh augite crystals and sharp-edged intact olivines are imbedded in a perfectly clear—only exceptionally milky—mass, showing no tendency to crystallize in separated sections; the mineral here apparently plays the same part as does the nepheline in certain rocks. Between crossed nicols parts remain dark; other irregular patches light up with faint bluish-gray colors; even here a division of the mass in triangular sections can occasionally be noted. This variety has not been analyzed.

Let us now rapidly review the results obtained:

The mineral which, with augite and olivine, mainly constitutes the rocks has sometimes exactly, sometimes only approximately, the composition of analcite, and should perhaps properly be regarded as a pseudomorph or analcite after nosean; the hexagonal form of the sections is also a proof in favor of nosean as the primary mineral; sodalite and leucite cannot with any degree of probability be regarded to have ever entered into the constitution d of these rocks.

It remains a very remarkable thing, indeed, that such a radical change could take place without effecting the augite or the olivine in the least, and so as to give the analcite in many cases absolutely the appearance of a primary mineral.

No instance is known to the writer where the analcite plays a part such as in the rocks here described; it either, as in Kaiserstuhl, fills former leucite crystals as an aggregate, or as in the plagioclase basalt (the "analcimite") of the Cyclopean islands fills cavities in the otherwise also very decomposed rock.

As helping toward an explanation of the Highwood occurrence, the not very constant composition and the great tendency to decomposition of the nosean should be taken into consideration.

The first stage in the decomposition of a nosean with 36.1 per cent. SiO_2 + 24.9 per cent. Na_2O, and 8 per cent. e SO_3 + 31 per cent. Al_2O_3 would be the removal of sulphates of sodium and aluminum, with addition of water and some silica. No change in the accompanying minerals.

The second stage is in contrast to the first characterized by aggregate decomposition of both the analcite and the accompanying minerals.

In fine fissures or in the middle of an analcite crystal brilliantly polarizing isolated zeolithic needles and small aggregates appear; they extinguish parallel to their larger axis, and have, parallel to it, a splendid cleavage in one direction; it is without doubt stilbite; macroscopically the stilbite occurs in larger quantities, filling cavities in decomposed rocks. The aggregates grow rapidly, and at last the analcite crystals are totally replaced by a maze of desmine needles in an opaque brown mass. The olivine is decomposed, the very resistant augites attacked, and chloritic products formed. From a chemical point of view the remaining alkali is dissolved, the percentage of f Al_2O_3 lowered, and the quantity of water doubled. A certain quantity of Ca present in the nosean and analcite is not extracted during these changes, but appears rather concentrated in the last stage.

Average composition of stilbit

	Per cent.
SiO_2	57.4
Al_2O_3	16.5
CaO	8.9
H_2O	17.2
Total	100.00

Such, if correctly interpreted, would be the history of the chemical changes in these rocks.

a In the described varieties the other constituting minerals retain the same appearance, and can be described together.

Augite.—Only one variety, the same occurring in all Highwood rocks, has been observed, and for the description the reader is referred to the trachytes (p. 725). The larger are often perfectly developed crystals up to 10^{mm} long; the smallest are imbedded as clusters of long microlites or small grains in the analcite mass. Sometimes a peculiar grouping of the small analcite crystals around a large and somewhat corroded augite crystal is seen.

Olivine.—Clear, sharp-edged crystals traversed by irregular cracks, generally ranging in size from 0.5^{mm} to 0.1^{mm}. Probably very rich in Fe, which may account for the energetic resistance to decomposing agents. Often surrounded by a thin fringe of brown biotite. Small inclusions in form of brown crystals (spinel) were b noted. The decomposition, beginning along the cracks at the same time as the formation of stilbite, proceeds rapidly and results in a brown, ferruginous mass.

Biotite.—Almost always microscopical, embedded as fine foils in the groundmass; color, brown; clear and fresh; especially clustering around the olivine.

Magnetite.—Irregularly distributed in the mass in form of small grains. At beginning of decomposition the hematite appears.

Apatite.—Small, sometimes rather short, slightly dusty, but clear prisms and sections, often as inclusions in augite. Proved to be apatite by microchemical tests.

It is certain that these Highwood rocks deserve a close and attentive study, much more extended than that c which my time and material allowed me to undertake; especially are chemical investigations necessary.

The collection was comparatively small, and does by no means include all parts of the mountains; future examinations will doubtlessly reveal rich harvests for the petrographer in the Highwoods and in the mountains of the Upper Musselshell river.

ROCKS FROM LINE OF ERUPTION IN FRONT OF MAIN RANGE, NORTHERN MONTANA, SOUTHWEST OF FORT BENTON.

[Feldspar basalts, Leucitoide basalt, Liparite, Dacite, Hornblende andesite, Diabase.]

Sun river, Birdtail, and Dearborn districts.—For 50 miles southwest of Fort Benton the great plains stretch out their monotonous, slightly undulating surface with nearly horizontal layers of Cretaceous shales and sandstones in d or above Hayden's No. 2. The first slight disturbances we notice near Sun river with its fertile and well-cultivated valley, doubly beautiful after the dreary, brown alkali plains. A few miles after crossing the Sun river we see the first eruptive rocks. To the right a long ridge appears, evidently a dike, and to the left a large, square butte (Table butte), rises to several hundred feet high, with steep sides, and a diameter of about a mile. This is clearly an overflow or intrusion, covering the softer Cretaceous sandstones. The ground is covered with detritus from the mountain; it is a dark, nearly black, dense rock with a few larger, prismatic augite crystals of the same characteristic appearance as those in Highwood eruptives.

In thin section.—Few large, clear, green augites, same variety as the Highwood augite. Olivine in small, decomposed grains; occasionally a small, single feldspar crystal, resembling sanidine. Groundmass composed of augite and magnetite microlites, imbedded in a colorless base. The microlites are often arranged so as to divide up e the colorless mass more or less clearly in round sections, always very small; these are isotropic or very faintly polarizing. The whole recalls decidedly a leucite basalt, but it may be difficult to prove whether the colorless base is glass, leucite, or analcite; a specific gravity separation and analysis should have been made, but unfortunately the time at my disposal did not allow it. A strong instance in favor of its being a leucitic basalt is that the powder dissolves easily in HCl, leaving the augite, of course, and the silica as a *powder*. The optical characteristics of leucite—the striation—one can hardly expect to see when the questionable crystals attain so small dimensions as the case is here.

Following Mr. Rosenbusch's nomenclature, I refer the rock to the leucitoid basalts, used when the leucite could not be conclusively proven as such.

A mile or two farther on a dike of a similar rock crosses the road, standing 20 to 50 feet high as an f irregular, rough wall, and running out in a southeasterly direction; and now a whole mountain group with serrated and sharp outlines appears near the horizon. They are the Birdtail mountains. To the south some regular, low, truncated cones, probably overflows or intrusions; southeasterly in front of us five large, steep cones or cupolas with a number of smaller peaks before and behind. The country around us begins to show undulating hills, the rocky wall of a dike traversing the sandstones occasionally.

The sandstone becomes coarser, more friable, and soon assumes a southwesterly dip of 10° to 15°. After a 17 miles'—from Sun river—ride we arrive to the stage station, Eagle Rock. Following a 20-foot broad dike, with soft, very decomposed mass up to a higher hill near the station, a good view is soon obtained of this wonderful landscape. Closely northward two square buttes again, called Twin mountains, an overflow or intrusion, showing columnar structure and resting on the sandstone layers. Southward dikes run everywhere, rising one behind the other with outlines never smoothed into curves by erosion, but sharp, torn, and irregular. Behind them rise the cupolas of

the Birdtail mountains, at a distance rather resembling the basaltic cones of Bohemia and Auvergne. The a laminated sandstones surrounding us are cut and worn by erosion into peculiar forms, resembling chairs, pillars, pulpits, and so on.

This landscape, surprising in itself, grows still more so by the uniform, dreary, brownish-gray color and the misty haze suffusing it. It is a volcanic landscape *par excellence.*

A few miles from Eagle rock the road runs close to one of the largest cones, the Birdtail mountain, so called from the peculiar curve its outlines present when viewed from the northeastern side. The name has been extended to the whole group. The height seems to be about 800 feet or 1,000 feet. Passing by it, however, it changes form, and now, seen from the west or northwest, appears narrower and sharper, showing in fact that we here have to do, not with a regular basaltic cone, but with a part of a large dike uncovered by erosion. b

The sandstones, being of so much looser texture than the eruptive, are very easily eroded, thus leaving the dikes carved out like monuments. Without a doubt, all the other cones of the Birdtail district are of similar structure.

The main difference between this eruptive center and that of Highwood seems to be that here the erosion has progressed more rapidly, no such marked metamorphisms as in Highwood having hardened the surrounding rocks.

In most cases the disturbances of the sandstones caused by the eruptives are very unimportant, and sometimes not to be perceived.

A few miles from the Birdtail mountain we cross a small divide and come to the Flat Creek valley; at this divide a thick sheet of a dark, basaltic rock covers a volcanic conglomerate of the same substance. It does not seem as if the conglomerate were contemporaneous with the Cretaceous sandstones; those have, in the neighborhood, a c steeper dip, while the eruptive sheet and the coarse conglomerate only are slightly inclined; it has the appearance of being formed after the beginning of the disturbances and erosion. From this center dikes composed of the same material radiate, one cutting the road a few hundred feet below the divide.

From here to Dearborn river, about 9 miles, we notice few indications of eruption along the road. Southward several dikes are seen. Between Dearborn river and Flat creek the Cretaceous, now coarse sandstones, form a flat anticlinal. This eruptive region, along the Missouri, from Table butte to Flat creek, has an extension of about 18 miles, its center being in the dikes of the Birdtail mountains. It is a late eruption, most probably approximately of the same age as the Highwood group, and, as far as my knowledge goes, only composed of basic augitic rocks, mainly feldspar-basalts. No complete collection was secured, only specimens from more prominent points.

Birdtail mountain (53 *et al.*).—A dark-brown, dense rock with slight resinous luster. Porphyritic augite d crystals of the common Highwood type.

Thin section: Large, light-green augites with inclusions of glass and magnetite; olivine throughout, but not abundantly, all more or less decomposed into a brown, opaque mass. Much magnetite, few apatite prisms. Plagioclase in large, irregularly bordered, prismatic crystals, all with polysynthetic twin structure, very decomposed. Groundmass consisting of few augite, predominating magnetite and feldspar microlites, probably exclusively plagioclase, mostly showing twin structure. The rock is rather decomposed, and oxide of iron is abundant.

Conglomerate, dikes and overflow, from Flat creek (54).—A dark gray groundmass with the usual augite crystals. *Thin section:* Fresh, light-green augite; very few olivines, decomposed; larger, tolerably fresh plagioclase; groundmass very glassy, with augite grains, irregular pieces of viridite and plagioclase crystals. Some magnetite and hematite distributed through the mass. e

These eruptives must consequently be classified as plagioclase basalts. In many points, for instance, in the green, fresh augite, characterized by long prismatic form and about equally developed pinacoids and prisms, these rocks resemble those of the Highwood group. There, however, the sanidine prevailed, and probably no plagioclase as microlite, certainly none as larger crystals, could be found in the examined basaltic rocks.

DEARBORN DISTRICT.

Altogether different from the Birdtail is the Dearborn eruptive region. The Dearborn river has its sources in the Main range, the Middle fork in Cadotte's pass, and flows into the Missouri after a course about 30 miles long. A good idea is obtained of the geological structure of the main range (briefly mentioned in the introduction), and of the eruptives in front of the same, by traveling up to the mountains along the river. f

The large fault of the main range here throws up the Cambrian slates and a part of the Carboniferous and Silurian rocks in contact with the (Laramie) coarse sandstones, dipping constantly toward the mountains. The dikes do not rise with irregular serrated forms as the basic eruptions of Highwood and Birdtail, but form lower ridges with softer outlines, or are not visible in the configuration of the ground. They further are confined to the Cretaceous strata, and do not seem to continue in the Paleozoic layers. They finally, with few exceptions, run approximately parallel to the general strike and the fault of the rocks; that is, have a northwesterly or somewhat more westerly trend, and this would, perhaps, suggest the idea of the dikes being really overflows, contemporaneous with the deposition of the Laramie sandstones. So much seems certain, that the dikes are older than the fault, and date from a time when the Laramie was in its original position, or at least only in an incipient stage of disturbance. We find, indeed, no younger basaltic rocks among the eruptives, but only hornblende-dacites, andesites, and liparites, the former eruptions, as proved elsewhere, having at least commenced already in Laramie formation. As to the liparites,

a the granular or porphyric varieties are intimately connected with the dacites. The glassy variety, also found at the Dearborn, we again find as overflow or intrusion at Sixteen-Mile creek; the date of eruption is not certain, but would seem to be rather to refer to the age of dacites and andecites than to the basalts and trachytes.

Liparite: Dike near the town of Dearborn (59); a light yellowish-gray rock, with rough fracture, many small quartz grains, and reflecting, white feldspar crystals. Brown mica very scarce.

Thin section: Quartz granules in great number, mostly rounded or irregular; only glass and groundmass inclusions, no fluid inclusions. Feldspar of two kinds: (1) By far predominating, presenting all the characteristics of sanidine; extinction measured on some smaller prismatic crystals; maximum, 5° along the crystals; few sharply defined individuals. (2) Smaller, scarcer crystals of rather decomposed and milky triclinic feldspar; variety,
b impossible to determine; groundmass, microcrystalline; composed entirely of sanidine and quartz granules. This is consequently a typical liparite of granular porphyritic development.

(64) From a 300 foot broad dike near the fault line of the main range on the Dearborn; has the appearance of a brown porphyry with glistening faces of small feldspar crystals.

Thin section: Porphyritic plagioclase, most likely oligoclase, in perfectly fresh crystals, carrying few inclusions. Most of them have a rounded or corroded form. By far the greatest number show twin striation, but not regularly, so that sometimes one-half of the crystal is simple, while the other shows very fine striation. Zonal and undulating extinction is common, even among the polysynthetic individuals. The few simple crystals doubtlessly also belong to the same variety as the striated. In most cases the rounded form and absence of cleavage permitted no rigorous
c optical examination, but in some instances an extinction of 2° to 3° along the larger simple crystals was measured. Extinction of hemitropic bands of the plagioclase was remarkably small, 10°+10°, and never higher, being repeatedly measured. The simple microlites extinguish about parallel to their length extension. Most of the feldspar is consequently oligoclase. No larger quartz granules. A few decomposed brown mica crystals.

Groundmass, glassy, characteristically liparitic. In a brown, microfelsitic mass, perfectly isotropic, are imbedded a great number light or colorless streaks and stripes, bent, twisted, and folded in the characteristic way. The white stripes have a micro-crystalline structure and are composed of feldspar and quartz.

Were it not for the large amount of plagioclase, I would, without hesitation, place this rock among the liparites. Strictly speaking, it should be classified as an acid, glassy porphyrite.

Hornblende-andesite: (62) and (63) are both specimens from dikes very near the great fault, and of a type which seems to be largely represented. (63) is a dark gray, very fine, granular rock; with naked eye small crystals of
d hordblende, mica, and felspar visible.

Thin section: Large, but scarce, biotites; few larger plagioclase crystals. Groundmass a maze of feldspar microlites of long prismatic form, some showing striation; single crystals extinguish from 0° to 3°; the feldspar is consequently oligoclase; besides hornblende very decomposed and with faint absorption. The microlites are embedded in a clear glass; (62) is similar, but more altered.

This andesite seems to be more related to the variety of dacite found on Belt creek, Little Belt mountains, than to the typical hornblende-andesite.

Hornblende-dacites: Also largely represented, and of a striking similarity with the Little Belt dacites. (60) are beautiful specimens from two large dikes at a small alkali lake, about 2 miles from Mr. Gillette's ranch. The rock presents a somewhat porphyritic habitus, with snow-white felspar crystals up to 3^{mm}, occasionally rounded quartz
e grains up to 2^{mm}; smaller hornblende needles and some dark mica in a yellowish-gray groundmass, with granular fracture.

Thin section: Large, rounded quartz grains, curiously enough without fluid inclusions. Grass-green, long hornblende crystals, with no very strong absorption; cleavage very well pronounced; maximum extinction about 18°. Biotites few and decomposed.

Feldspar mainly if not exclusively plagioclase, of those two varieties already described at the examination of Little Belt eruptives and Highwood conglomerate. (1) Short rectangular or square sections, often zonar structure, very fine striation, gray colors between crossed nicols. Maximum extinction of hemitropic bands here again measured to 10°+10°; doubtlessly oligoclase. (2) Larger prismatic crystals, with scarce and oft-missing striation; colors between crossed nicols light brown, deep Labrador blue. No sanidine noted. Groundmass, very fine micro-
f crystalline of granular feldspar and quartz.

(65) from a dike several miles farther up, shows macroscopically large yellow sanidine crystals in a groundmass of smaller feldspar grains, decomposed mica, and quartz.

Thin section: Smaller and larger rounded quartz grains, with numerous fluid inclusions with moving bubble; also glass inclusion. Small decomposed crystals of hornblende and black mica. The feldspar crystals of medium size are all a somewhat decomposed plagioclase (oligoclase). When a part of the larger sanidines is cut by the section it appears with the usual characteristics of that mineral. Groundmass micro-crystalline, not resolved by low powers, composed of quartz and irregular simple feldspar granules (plagioclase or sanidine?); no hornblende in the groundmass. The quartz, especially in the groundmass, is characterized by a pronounced granophyric structure, recalling again the Little Belt dacites. Every quartz grain of the groundmass appears as if scattered around a certain space in smaller grains, optically with parallel orientation.

The sanidines, known also with smaller development from Little Belt connect this dacite with the liparites; a the line of demarcation between the two species becomes difficult to draw distinctly.

Still more largely the sanidine seems to be developed in a dike of similar material on the North fork of Dearborn. Professor Pumpelly has collected from that locality a quantity of larger perfect orthoclase crystals up to 3^{m}, extended along the clino-diagonal and generally presenting the combination O–P . ∞ P ∞ . ∞ P. They do not appear as sanidine, but resemble typical orthoclase. The rock carrying these crystals I have not seen.

A few dikes of a typical diabase, in the Cambrian slates near the divide, will be mentioned farther on, in connection with similar rocks from the Big Belt mountains.

MULLEN PASS AND JEFFERSON COUNTY ERUPTIVES. b

Hornblende-granitite, Liparites—The geology west of the Missouri is but little known. The first range on the west side of the broad Missouri valley, between the two cañons, is reported as composed of limestone and other sedimentary rocks. Soon, however, going west, we come into an extensive field of an eruptive granite.

One interesting point is the contact at the pass height of the Northern Pacific, Mullen tunnel; from there the line of contact runs southeast, passing close to Helena and Jefferson City. The granite contains mineral lodes in great number and indeed some of the most valuable mines of Montana. The study of the age and qualities of this eruptive, to which I shall refer in the following as the *Jefferson granite field*, is of great interest. I shall first describe it as it appears at Mullen. c

The west slope of the main range, opposite Cadotte's pass, seems to be largely composed of Cambrian or Silurian quartzites and slates. They also appear 10 to 20 miles north of Helena as green and red slates. Coming down from the hills into the valley of Little Blackfoot, 8 miles from Mullen pass, broad dikes of a dark, porphyritic eruptive appear, cutting a series of sedimentary rocks. It appears on examination that the dikes intersect Jurassic strata, identified by fossils, underlaid by some Carboniferous limestone; and that farther on the rocks are considerably disturbed, and consist of large masses of a hard, gray hornstone or quartzite, unknown to such an extent in the general series. This quartzite seems to follow below the comparatively small quantity of limestone. In this quartzite, a few miles from Mullen, is a dike of a granite identical with the one of the large eruptive; a mile west of divide is a large dike of a black, dense eruptive.

In the valley between this ridge and the divide there is a formerly-worked coal-seam; strike north 10° east, dip, 20° west. About a quarter of a mile southward, at the tunnel, we are already in the typical granite. At the d divide, west side, there is a dike of a light-colored, porphyritic eruptive, probably a liparite. On the other side, we suddenly come to a series of sedimentary rocks striking northeast and dipping southeast, the lower part of which consists of quartzites and the upper part of Carboniferous limestone (*Spirifera centronata and Encrinites* at the road); the highest part at the contact with the granite shows alternating bands of black and white limestone, the latter crystalline, saccharoidal, and very metamorphosed, without fossils. The granite at the contact is coarse granular. For several miles going east the creek runs exactly on the contact line between the granite and the always crystalline white limestone. To the right the eruptive field extends, a rough and broken country, with high, rounded cliffs, showing the characteristic "woolsack" structure of the granite.

A few miles below the divide, always following the railroad, we leave the granite and pass over a 4-mile long monoclinal dipping east, similar to the one of Little Blackfoot, with gray Carboniferous limestone, a series of hard e flinty quartzites, and finally a succession of gray and brown slates cut by dikes of a light-colored eruptive similar to the one from Mullen; no fossils. Approaching Helena, the ground is more covered and the structure not so easily ascertained. Near Helena, Jefferson City, and Clancy the line is continually marked by a zone of metamorphosed limestones or dolomites; portions of the limestone seem sometimes to be included in the granite.

From all these stratigraphical facts we may draw a few conclusions: (1), that the granite is eruptive, and that it cuts strata at least as high as the Carboniferous limestone, and that in the series intersected we find Jurassic rocks (Logan's ranch, Little Blackfoot); (2), that the phenomena of metamorphosis at the contact very closely resemble those which elsewhere have been found to mark the boundary line of eruptive granites; (3), that, probably in Cretaceous or Tertiary time, eruptions of liparitic and andesitic rocks have again intersected the district.

A very puzzling question, however, is the occurrence of a coal-seam of probably Laramie age at Mullen f tunnel; possibly the great eruption is of Jurassic age, and the Cretaceous strata deposited in an insulated basin unconformably on the older rocks, disturbed by the granitic outburst, have since in their turn participated in the general great post-Cretaceous movements. The problem is very much in need of further investigation.

In many points the petrographical examination confirms these conclusions.

I had at my disposal specimens of the granitite from Mullen tunnel, and from Gregory mine, 16 miles southeasterly in the same eruptive. The same description can be used for both occurrences.

Macroscopically, it is a fresh, coarse, granular rock, in which can be distinguished quartz, biotite, much green hornblende, and a white feldspar, and can consequently at once be classified as a hornblende-granitite.

Thin section: Numerous irregular quartz granules with many fluid inclusions; only the smaller with moving bubble; a greenish-yellow biotite, not very largely represented; green hornblende in irregular crystals with strong absorption, sometimes decomposed to viridite, and often associated with grains of magnetite.

a *Feldspar.*—Orthoclase scarce, plagioclase by far predominating, with splendid striation and generally vivid colors. Maximum extinction of hemitropic bands, 22° + 22°. It is consequently a feldspar approaching Labrador. Few inclusions. Apatite in long thin, needles, and some titanite.

The above-mentioned granite dike near Mullen pass is exactly similar, but rather decomposed.

The similarity to Zirkel's "Jurassic granite" from Nevada is immediately and clearly perceived, and thus the microscopical investigation confirms the results obtained from observations in the field.

A specimen from the large, dark dike one quarter mile west of the pass was also examined. It is a black, hard, and perfectly dense rock.

Thin section: Very decomposed, and apparently containing much calcite. Irregular pieces of a green,
b somewhat dichroitic chlorite, presumbably decomposed hornblende, imbedded in a crystalline mass of irregular feldspar crystals, mostly plagioclase as far as can be seen on account of decomposition. The dike is therefore composed of an aphanitic diorite, and probably contemporaneous with the great granite eruption.

Near this dike Mr. Davis found some crystalized garnet, a mineral very often appearing at the contact of dioritic and granitic rocks with sedimentary, calcareous layers.

In the interior of the field the pure granular structure of the granite does not seem to be continuous; it changes suddenly or more gradually to a denser dark-gray or dark-green porphyritic facies, with less quartz and much decomposed hornblende. In some of these varieties I have also found a light-green augite, very decomposed and with imperfect cleavage.

c The above-mentioned white or light-yellow, hard, porphyritic rock, occupies considerable room in the interior parts, for instance at the Gregory mine, where it covers an area of 1 or 2 square miles; it has all the characters of an overflow in connection with dikes; in fact the upper levels of the Gregory mine are in this eruptive, while lower down the granite and peculiar facies of the granite suddenly appear again.

A complete examination of this younger eruptive has not been made; from the few sections prepared it appears that part of it is a mica-andesite containing porphyritic plagioclase with zonar structure, brown mica scarce, and a ground mass of micro-crystalline structure, with small, often polysynthetic feldspar microlites. Predominatingly, however, a light-yellow liparite occurs, with a great amount of sometimes large granules of quartz, and a generally porphyritic, micro-crystalline structure.

The ore-veins cut through both liparite and granite, and are in their turn cut by several minor faults or "breaks".
d We must, consequently, attribute to them a Tertiary age.

One facies of the granite found in a cross-cut in Gregory mine is of peculiar interest as compared with the eruptive dikes of Big Belt mountains; macroscopically dark gray, dense.

Thin section: Small but sharp and perfect quartz crystals (double pyramid), few augites decomposed to a pale-green substance, often preserving the short prismatic crystals of the pyroxene. Numerous small, irregularly rectangular, somewhat opaque and decomposed plagioclase crystals with broad polysynthetic bands—all imbedded in a very fine, crypto-crystalline gray groundmass. This peculiar mode of development may be designated as a quartz-augite porphyrite.

DISTRICT OF BIG BELT MOUNTAINS.

[Quartz-augite porphyrite, Diabase, Quartz-diabase, Hornblende-andesite and Dacite, Augite-andesite, Liparite.]

e It is interesting to note the recurrence of those older, acid eruptions in the Big Belt on the opposite side of the Missouri, about 30 miles east of the Jefferson field.

The large anticlinal of Cambrian, more or less metaphorized, slates, constituting the main chain of Big Belt, is cut on its eastern flank by several minor dikes, and also contains a massive eruption or very large dike. The old celebrated diggings of Confederate gulch contain numerous boulders of a hornblende granitite, very similar to the one already described; going upward, we find that all these boulders come down the narrow cañon of Boulder creek, branching off southeasterly into the wooded and not easily accessible mountains; although following the cañon for several miles we did not succeed in finding the source of the granitic boulders. They doubtlessly come from a smaller eruptive near the headwaters of Boulder creek.

A marked increase in the metamorphism of the dark slates was noted, going up Boulder creek; soft and
f laminated at Confederate gulch, they, higher up, become hard and glistening.

Fifteen miles southward we visited the interior part of Big Belt again, going up Deep creek toward Bald mountain, the highest peak in the range (about 10,000 feet). We still are in the large slate anticlinal. High up, on the slope of Bald mountain, or rather of the peak next to it, we noticed several dikes of a porphyritic rock.

The first dike—lowest down—a very weathered, white rock, with large, perfect quartz crystals—the double pyramids, so characteristic of the porphyries.

Thin section: Large, very decomposed plagioclase crystals; some irregular feldspar crystals without striation—may be orthoclase. Quartz in angular sections, with numerous fluid inclusions. Few prismatic, light green, and fibrous crystals; decomposed augite; very few clear unaltered granules of pyroxene, markedly dichroitic—grass-green to faint yellowish-green. No good extinctions could be measured. Some thin stripes of a brown substance and opacite, possibly altogether decomposed hornblende; groundmass predominating, light colored; crypto- to

micro-crystalline, very decomposed. The rock must be classified as a *quartz-porphyrite.* Farther up again, at an **a** altitude of about 8,000 feet, there is another dike with a similar, but differently developed rock, with beautiful porphyritic structure. In a gray or greenish-gray dense groundmass are imbedded round quartz grains up to 1^{cm} in diameter, and equally large gray or light red plagioclase in rectangular or square sections. Sometimes a feldspar crystal is exposed by weathering and then shows the form of albite, ∞ P and O P being about equally developed.

Thin section: Very decomposed, feldspar and groundmass being filled with kaoline. The large feldspar shows polysynthetic structure, with generally vivid colors; maximum extinction of hemitropic bands, 20° + 20°. Large rounded quartz grains, sometimes fissured and the cracks filled with groundmass; numerous fluid inclusions. A few irregular grains of pyroxene; here also dichroitic. All imbedded in a decomposed, gray, micro-crystalline groundmass of feldspar and quartz. It is consequently a quartz-porphyrite. This rock, although coarser **b** porphyritic is exactly similar to the one described from the granite field near Gregory mine; and thus the age of these dikes is established as pre-Cretaceous and post-Carboniferous, probably Jurassic, and contemporaneous with the hornblende-granitite. Still farther up, near the summit, the greenish slate contains another dike with a dark gray, dense rock, without any crystals visible.

Thin section: This also appears very decomposed, but similar to the already-described dark eruptive from Mullen. Irregular pieces of decomposed hornblende, beside some long, fresh crystals; opacite throughout. Some larger, decomposed plagioclase crystals; groundmass very micro-crystalline; constituents hardly discernible, but probably feldspar and quartz. As the presence of the quartz is not proven, we must call it a hornblende porphyrite.

Thus we see that, although the Jurassic eruption of acid magma mainly took place west of the Missouri, it was **c** also extended eastward to the Big Belt range, in form of dikes and smaller massives. The magma is quite differently developed, for instance—(*a*) as hornblende granitite (plagioclase predominating; (*b*) as quartz porphyrite (large quartz crystals, some augite); (*c*) hornblende porphyrite (with quartz presumably in groundmass).

We notice that the pyroxene is never developed in the coarser, crystalline varieties; only—and sparingly—in the porphyritic and aphanitic varieties. These rocks can hardly be mistaken for younger, liparitic or dacitic eruptives. The feldspar, for instance, is very different, showing broader striation with vivid colors, and doubtlessly approaches labradorite.

Besides these dikes of an older, acid magma, there are others of younger age. A large dike of typical hornblende-andesite can be traced for several miles from the place where it cuts Boulder cañon. It is dark green, with small white feldspar crystals. **d**

Thin section: Green, fresh hornblende, in prismatic crystals; square and rectangular plagioclase crystals with zonar structure. Little opacite; groundmass mostly feldspathic, micro-crystalline.

At the mouth of Confederate gulch, 5 miles lower down in the foothills of Big Belt, composed of steep, dipping Silurian quartzite and limestone, girding the Cambrian anticlinal, there is an andesitic, double dike, running about parallel to the strike, about N. 70° W. It is about 200 feet wide, and consists of a dark green and a brown rock between which there is a breccia, showing the green eruptive to be the older, pieces of it being included in the brown.

The former is a (hornblende) dacite of a very different appearance, however, from the dacite of Little Belt and Dearborn. Composed of numerous small clear, quartz crystals, somewhat decomposed plagioclase in rectangular crystals, and a green viridite (probably decomposed hornblende) filling the greater part of the room **e** between. Some crypto-crystalline groundmass.

The latter is a pure andesite, with clear, sharp plagioclase crystals with zonar structure; extinction maximum between hemitropic bands, 23°+23°. Small amount of decomposed hornblende. Some small, violet-brown doubly-refracting crystals. All included in a glassy and micro-feldsitic groundmass, with some feldspar microlites.

Here I will also mention a diabase appearing as dikes most constantly in the red, Cambrian, or Silurian slates. It is purely crystalline, heavy, and dark. Macroscopically, white feldspar faces and granules of a dark mineral are seen. I have seen it at Cadottes pass, at the mouth of Confederate gulch, near Deep creek; also in the foothills of Big Belt; finally, 20 miles southeast of Deep creek, near the North fork of Sixteen-Mile creek, always in the red slate, never in high strata. The dikes are about 50 to 100 feet wide, and always easily discernible on the surface by the deep-brown rusty color it imparts to the ground. **f**

A specimen from Cadotte's pass is composed of fresh triclinic feldspar, irregular granules of a violet-brown augite, and much magnetite mostly surrounding the augite.

The dike from Deep creek, although macroscopically similar to this, presents on microscopic examination a most peculiar and interesting feature. It is a quartz diabase and a quartz diabase with granophyric structure of a rarely-seen beauty.

Feldspar.—Irregular granules and long crystals; generally gray colors and very fine striation; a few without striation, but from general appearance they must also be plagioclase. A few crossed striations. Not striated, rectangular sections extinguish obliquely. Few inclusions; rather fresh appearance.

Augite.—Irregular granules, nearly colorless or very pale-brown or green; now very decomposed, often only showing a remaining nucleus of fresh substance. Decomposes first into hornblende; then the hornblende gradually changes to chlorite, and the chlorite to brown or dark ferruginous products. Sometimes the augite changes

a directly to yellow and brown products. The hornblende often appears as the direct continuation of an augite crystal, the cleavage extending from the latter to the former. The whole process is exactly similar to the general decomposition of diabasic augite as stated by Rosenbusch. Apatite in long needles. Magnetite abundant.

Quartz in large quantity, showing the most beautiful granophyric structure; the fragments of one individual—often regularly triangular in shape—are dispersed through the feldspar; very often also forming the threads of a perfect network; the large quartz granules are on the whole poor in inclusions, but carry some fluid pores with moving bubble.

Quartz diabases are of very rare occurrence, but a quartz diabase with granophyric structure I can safely claim as new to science.

The country south of Big Belt mountains, including the Bridger mountains, Sixteen-Mile Creek mountains,
b and the Bozeman district is on the whole not very rich in eruptive rocks, the limestone sheet and the Laramie sandstone covering most of the region.

On the headwaters of Gallatin and Madison rivers the eruptives must occur again on a large scale. Not having visited these districts, I can unfortunately say nothing of their character. At Bozeman and in the Gallatin valley pebbles and small boulders of a very porous and vesicular black lava occurs, indicating large eruptions, probably recent overflows.

The Cretaceous basin of Sixteen-Mile creek, above the limestone cañon, presents some interesting points.

Along the river there is a good exposure of Cretaceous rocks. Near the crossing of the road from Dry creek of Bridger mountains to White Sulphur Springs I noted the following section: 25 feet light-gray coarse (Laramie) sandstone; 60 feet dark greenish-gray sandstone, resembling a tufa, with obscure plant remains; 12 feet coarse
c volcanic conglomerate of dark, often glassy eruptives. A few miles down the creek the same section, practically, is observed, but here a sheet, probably 20 feet thick, of a brown or yellow porphyry—a liparite—covers the conglomerate. The sandstone belongs most undoubtedly to the same Laramie formation, so enormously developed on the eastern slope of the mountains. The conglomerate and tufa occurring in it are of interest as indicating the age of the eruptives. Now, thin sections of the boulders in the conglomerate prove them to be prevailingly pure augite andesites; therefore the age of these coincides with that of the Laramie deposits. The andesite appears as a dark-green rock, with somewhat glassy luster and small glistening feldspar crystals.

Thin section: Feldspar very fresh, of rectangular form; all plagioclase, with fine striation and gray colors of polarization. Presumably oligoclase. Very few, but clear and fresh light-green augites (not rhombic pyroxene), in irregular granules. Groundmass prevailingly glassy, with few feldspar and augite-microlites. The glass is filled
d with opacite or hematite dust, sometimes micro-fluidally arranged in strings.

The exact position of these conglomerates in the general series of the Laramie I am unable to fix.

The second eruption in time is that of the red liparite. I can not venture to decide whether we here have an overflow contemporaneous with the sediments or an intrusion. If the former, the time of the liparitic eruptions would be placed much farther back than has been generally assumed. It is a salmon-colored, or yellow, dense rock, without any porphyritic crystals.

Thin section: Light colored, irregular, round spots, bent and twisted stripes of a microcrystalline mass of sometimes clearly discernable quartz and feldspar; thin fissures, running irregularly and filled with chalcedony, the light-colored stripes are imbedded in a brown microfelsitic groundmass; hematite granules microfluidally arranged, often surrounding the lighter parts. It is a typical, liparitic groundmass.

e That not all augite andesite is necessarily of Laramie age is shown by a dike, as far as I could ascertain, *cutting* the sandstones near Shields' river, east of the Bridger range, about 12 miles from Livingston. It is a typical, somewhat decomposed augite-andesite.

Another Laramie conglomerate, of which, however, I am able to fix the position more accurately, occurs near Bozeman coal-fields. Mr. J. E. Wolff, of the Northern Transcontinental Survey, kindly furnished me material for a rapid examination.

The total thickness of Laramie series at the coal-fields, as measured by our party near Livingston, exceeds 30,000 feet; at a certain point above the Jurassic strata fossils are found, identified by Prof. R. P. Whitfield as belonging to Hayden's Cretaceous No. 2; 2,000 feet above these the Bozeman coal-beds appear; 200 feet above these we find the conglomerate, consisting of hornblende-andesites, which, consequently, must be of Lower Laramie
f age.

Macroscopically, the pebbles appear as a dark-green or gray rock, with white feldspar crystals.

Thin section: Only triclinic feldspar, with large extinction; mostly regularly rectangular crystals, with zonar structure by inclusions. Hornblende readily to be recognized, but very decomposed to opacite; groundmass brown, microcrystalline, with some glass. Another specimen has the hornblende decomposed to viridite.

There is a great similarity between these andesites and those described from Big Belt mountains at Boulder creek.

From all this it may be seen that we must not attempt to limit the periods of the eruptions too much from inclination to systematic division. Probably the andesitic eruptions began early in the Laramie period and lasted with different intensity till or after the end of the same.

CRAZY MOUNTAINS.

Every traveler on the Northern Pacific must have noticed the rugged and majestic group of the Crazy a mountains north of Livingston. Their perfect similarity to the Highwoods—only on a larger scale—is a fact which I could not but observe when seeing them from a distance. I believe Mr. Hayden mentions them in his before-mentioned report on the Yellowstone and Missouri as the "Crazy Woman's mountains", and suggests their being "an anticlinal uplift". Mr. J. E. Wolff, of the Northern Transcontinental Survey, who has visited them, gives an account which altogether proves their perfect analogy with the Highwoods. They are formed of a very shallow synclinal of Cretaceous sandstones, nearly horizontal even at the highest points; the layers are highly metamorphosed, and cut in all directions by a maze of eruptive dikes. Mr. Wolff collected some specimens from these dikes, but as yet no examination of them has been made(*a*); a large field, promising rich returns, is here open.

RÉSUMÉ. b

I shall now attempt to condense, in a few words, the more important conclusions derived from the study of some of the eruptive rocks in Montana.

The oldest eruptive is without doubt the granite with red orthoclase, found as dikes in the gneiss at the headwaters of Belt creek, Little Belt mountains. The second eruption of Cambrian or early Silurian age is a diabase, sometimes appearing as a quartz-diabase, in which the quartz has a granophyric structure (quartz pegmatoide, Levy). During the rest of the Paleozoic era complete calm appears to have reigned here as well as in other parts of the Rocky mountains.

In the Jurassic period, presumably, a large and extensive eruption of acid magma took place, developed in c massives or dikes as dioritic granite and quartz porphyrites, the latter dividing into augitic and hornblendic porphyrites.

The most remarkable and varied part of the history of eruptions is that comprising the Laramie and Tertiary series. The order of succession is not always easy to prove, especially as no sedimentary rocks younger than Laramie are found in the districts in question. One definite conclusion is that the andesitic eruptions commenced late in the Cretaceous period or in the Laramie.

While Mr. Clarence King pronounced the hornblende-andesites as pre-Miocene, we can here more definitely say that at least a part of them are of Laramie or even pre-Laramie (marine Cretaceous) age.

According to the elsewhere established sequence, the next younger eruptive would be the hornblende-dacites (sometimes approaching liparites) appearing as massives in Little Belt mountains, and as dikes in Laramie in d front of the main range. I have no direct evidence of their age compared with that of the andesites. In the Highwood mountains we find them together with andesites in a Laramie conglomerate.

No augitic dacites, and only few augite-andesites were found.

Liparites are found in front of the main range as dikes in Laramie strata.

No liparitic or basaltic overflows or lava-fields were met with; they doubtless exist, though, in southern Montana toward the Idaho boundary line.

The most recent of the eruptives appear to be the trachytes and basalts. They occur generally intimately associated, and doubtless belong to one and the same period of eruption. They are post-Laramie, presumably of Pliocene age. The trachytes are nearly all developed as augite-trachytes, and some are amazingly rich in augite. The basalts are in part plagioclastic; another part consists of the new group of the analcite (nosean) basalts, e originally composed of nosean, augite, and olivine, but with the nosean extensively changed and metamorphosed into analcite. These eruptives generally occur as dikes, sometimes crowded together in great number; the trachytes appear to be younger than the basalts.

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a Mr. J. E. Wolff has described the Crazy mountains and their rocks in the *Neues Jahrb.*, 1885, I, p. 69, and in a more extended paper printed for the Northern Transcontinental Survey —*Notes on the Petrography of the Crazy mountains*, etc., Heidelberg, 1885. Andesites (propylites), tephrites, diorite, and some metamorphic sedimentary rocks are found there.—R. PUMPELLY.

From unpublished MS. material of the N. Transcontinental Survey.

MAP TO ILLUSTRATE GEO. H. ELDRIDGE'S REPORT ON THE MONTANA COAL-FIELD,

The base map is from Stieler's Hand Atlas, 1881.

MONTANA COAL-FIELDS.

By Geo. H. Eldridge.

The area comprising the explorations mentioned beyond includes the eastern slopes of the Rocky mountains in Montana, the portions of this Territory lying east of them, and what may be designated as the Mouse river district in northern Dakota. It must not be understood that this entire stretch of country is explored in detail throughout, but only those portions which at the outset promised the largest and most important coal deposits. c The remainder was only examined in so far as it could be done in the casual movements of our corps from one locality to another during the two years spent in the work.

The western boundary of this area is in most instances the front ranges of the Rocky mountains (*vide* general map, Plate LV), though toward the south, in the vicinity of the Bozeman pass, the natural thoroughfare of the Northern Pacific railroad, exploration has extended within this limit to the headwaters of the Missouri river.

The ranges constituting the Rocky mountains in Montana reach an altitude above sea-level of from 6,000 to 11,000 feet, the average being nearer 8,700 feet, with the plains at their eastern base coming usually between the levels of 4,000 and 5,000 feet.

The region drained by the headwaters of the Missouri and Yellowstone rivers, since it has to do more directly with some of our fields of exploration, needs a little closer attention. At Helena we have but two ranges. "The d Main," to the west of which the western slopes form a part of the Pacific water-shed, and "The Belt", just east and across the valley of the Missouri, on the eastern slopes of which rise the waters of those tributaries of the Missouri, which drain the prairies farther out, the "Deep" or "Smith's river", and the northern branches of the Musselshell. Above Helena the main divide between the waters of the Atlantic and Pacific forms a prominent and large arc, one end, the northern, lying just west of Gallatin city, the point of confluence of the three tributaries forming the Missouri—the Gallatin, Madison, and Jefferson rivers; the other end, the southern, lying at the western boundary of the Yellowstone National Park, the interior of this extensive curve being drained by the Jefferson river and its tributaries. The Madison and West Gallatin both flow northward from the Yellowstone Park, separated from each other and the Jefferson to the west and the Yellowstone to the east by bold and lofty spurs running down from the main divide. e

The Belt range from the latitude of Helena passes southward in a rather broken line and unites with the range forming the divide between the West Gallatin and Yellowstone rivers, and by this also with the Yellowstone range south and east of the Yellowstone river. From the Belt range, as thus described, extend eastward on to the prairies several important spurs. The highest and most imposing of these is known as the Crazy range, passing off from the Belt range at a point about 30 miles north of the Yellowstone and running southward to a point opposite the Old Crow agency on this river. It is geologically an independent range, over 11,000 feet high, and almost wholly a mountain of erosion, while the topography of the Main and Belt ranges proper is generally that due to the combined effects of upheaval and erosion. Against the eastern slopes of the Belt and Crazy ranges and their spurs rise the southern tributaries of the Musselshell and the smallest of the streams feeding the Yellowstone, this river receiving the bulk of its waters from streams coming from the mountains lying to the south of it. f

The second prominent range passing off from the Belt mountains is that of the "Little Belt," which is continued eastward in the upheaval of the Snowy and Little Snowy ranges, the three together forming the prominent divide between the Musselshell and Judith rivers. The first two reach an altitude of over 8,600 feet the last of about 6,000 feet above sea-level, the prairies at their bases being in the neighborhood of 5,000 feet. Still farther to the north comes the group of the Highwoods, another geologically independent height, having an altitude of 7,000 feet, and occupying the bend of the Missouri river at a distance of 18 miles from it. The Highwoods, with the high country connecting them with the Little Belt mountains, form the western rim of the agriculturally-important Judith basin, and the divide between it and the Missouri river, the eastern wall being the anticlinal of the Judith mountains with the hills connecting them with the Snowies farther south. The two important anticlinal upheavals of the Moccasins, near the eastern side of the Judith basin, should also be noted in passing. The streams draining these

a border mountains northward, via the Judith basin, all have a fair amount of water, while the southern and eastern slopes furnish only the slightest amount, most of the coulées being entirely dry, the valley of the Musselshell having all its large streams on the south side, coming down from the Elk ranges, between it and the Yellowstone river. Owing to the Crow Indian reservation occupying the country south of the Yellowstone, our explorations there were very limited, but may be regarded as bounded by the bold and rugged heights of the Snow mountains, the front wall of the Rockies at the head of Clark's Fork, and by the Big Horn mountains farther east. These ranges with the mountains and valleys beyond to the south, furnish nearly the entire amount of water of the Yellowstone river, the streams being numerous and large, while those coming from the north are for the most part dry.

The topographical features of the prairies are very much the same throughout the entire area, consisting as they do of a general prairie level, on the one hand cut with coulées usually from 20 to 100 feet deep, and on the b other dotted with buttes or marked by low ridges; one side among these last has often a gentle slope to its summit, while the other presents an abrupt bluff of sandstone or arenaceous clays, the crest being usually marked by a scant growth of stunted pines. Concerning the drainage of this great Cretaceous basin, it is a remarkable fact that the three large rivers receive the bulk of their waters from the south, the streams from the north being either dry or of very little importance.

The general geology of the Rocky mountain ranges will be found in the report of Mr. Davis, who has made their features a subject for special study. Our own explorations were conducted entirely with reference to the discovery of coal deposits, and we shall therefore present our notes on the general geology in a manner that will have a direct bearing on the occurrence of the coal and its relations to the associated strata. Coal-beds are found c at various horizons in the Cretaceous from the Dakota upward, and we naturally turn first to the identification of the base of this group. Along the western border of the great plains of Montana, either forming the foot-hills next the higher ranges or occurring on the slopes of the ranges themselves, are to be found the strata of Jurassic age. On all the subordinate ranges also, the Little Belt, the Snowy, the Moccasins, and probably the Big Horn, great anticlinal folds, there occur the same Jurassic rocks, varying very slightly if at all in their characteristics. Noticeably persistent and uniform is the development of the limestones with their accompanying fossils, rendering them most easily recognized wherever met, and a most excellent indicator of our proximity to the overlying coal-bearing Cretaceous strata. The following section (Figure 1 of the geological cross-sections, Plate LVI) from the lower cañon of the Yellowstone river outward onto the prairie will give an idea of the rocks met with in the Belt mountains in the southern portion of our field. It is by Professor Pumpelly. The section is numbered from below d upward, the numbers in the text and figure corresponding.

No.		Feet.
	1. Heavy beds of gray limestones, 1,000 to 2,000 feet thick, probably Carboniferous, in part at least	
	2. Drab limestones with red stained face	60
	3. Covered, but probably shales	158
	4. A white quartzite stained brown	60
	5. A white quartzite with cavernous layers	48
	6. Covered, but probably a conglomerate	36
	7. Drab slaty limestone, overlaid by a quartzite	44
	8. Conglomerate and white quartzite	48
	9. Limestones, very fossiliferous	72
e	10. No distinct outcrop, but apparently light quartzites or sandstones weathering with rounded corners	318
	11. Coarsely crystalline fossiliferous limestone	28
	12. Covered, but probably a shaly sandstone	60
	13. Sandstone, slightly ferruginous	53
	14. Covered, but probably same as No. 13, excepting that the upper part is more shaly	112
	15, 16. Sandstone	120
	17, 18. Sandstone with conglomerate layers	355
	19 and upward. Generally sandstones with shaly layers	
	30. A sandstone just below which probably occurs the coal-beds of the Bozeman field	

No attempt is made to assign the strata to their proper age, as our data are not sufficient. In a general way, however, the points to be noted are the heavy beds of pre-Mesozoic limestones (No. 1 of the section just given), the Jurassic limestones (No. 9), and the interbedded conglomerate and sandstone (No. 17), which are probably near the base of the Cretaceous. Another characteristic not observed at this point but generally present and very prominent, f even at great distances, is the presence of beds of shale and sandstone of a very brilliant red occurring beneath the Jurassic limestones, usually somewhere between 100 and 150 feet, which may possibly rightly be considered of Triassic age. These features of the strata underlying the Cretaceous are everywhere present, though marked more prominently at some points than at others. On the east side of the monoclinal ridge of the Bridger mountains, seen in the map of the Bozeman coal-field (Plate LXII) they are especially prominent.

The Belt mountains at the head of the South fork of the Musselshell, 5 or 6 miles above its junction with the North fork, present these same general features (Figure 5, Plate LVI). We have at the base of the section given the Jurassic limestones (No. 2 of the section), which are underlaid by about 400 feet of red and green shales (No. 1), interbedded with one or two thin strata of limestone and a thin basal conglomerate, there coming under all the Carboniferous limestones. The Jurassic limestones are overlaid, as shown, by sandstones which are

From unpublished MS. material of the Northern Transcontinental Survey.

GEOLOGICAL SECTIONS NEAR THE COAL-BEARING STRATA IN MONTANA. By Geo. H. Eldridge.

Fig. 1.—Section through the lower cañon of the Yellowstone river (see Plate LXII).
2.—Section through the Bozeman coal-field.
3.—Section on the Judith coal-field (see Plate LXVII).
4.—Section of the west slope of the North Moccasin.
5.—Section of the Belt mountains.
6.—Section of Belt butte.

alternately heavy-bedded and shaly, succeeded at about 400 feet by a conglomerate of coarse and fine pebbles, **a** showing an outcrop of about 40 feet, and followed at about 200 feet by another bed of much heavier and coarser material, the two beds being separated by sandstones of varying texture and color. The entire section, numbered from below upward, would be:

	Feet.	
1. Red and green arenaceous shales, with limestone intercalations and a basal conglomerate	400	
2. Jurassic limestones	90	
3. Gray sandstone	90	
4. Covered, but probably like No. 3, perhaps a little more shaly	175	
5. Light-colored and yellowish-gray sandstones forming prominent crests	32	
6. Covered, but undoubtedly like No. 5, though shaly	60	
7. A rusty-gray sandstone, weathering red and forming a prominent ridge	27	**b**
8. Like No. 7, but more thinly bedded	15	
9. Conglomerate, pebbles of size of a bean and upward, probably Cretaceous	40	
10. Light calcareous sandstone, reddish at top	90	
11. Covered, probably like Nos. 10 and 12	50	
12. Heavy-bedded gray sandstones	70	
13. Heavy bed of coarse conglomerate	65	

As in the Yellowstone section, the actual base of the Cretaceous was not determined, but the strata are all so clearly defined that no doubt can ever be entertained as to the proximity of the series which is liable to contain important coal-beds. Though some members of the series are altogether wanting, or at least thinner in this section than in the first, still the important general features referred to above remain unchanged. **c**

On the southern slope of the Snowies we meet with comparatively the same section of red and variegated shales, and Jurassic limestones, overlaid by heavy-bedded sandstones, followed by the coarse conglomerates. In the Judith basin, in the foot-hills on the north of the Little Belt mountains, we have a variation of the sequence thus far observed in the conglomerates coming immediately above the Jurassic limestones and not being again met with in the ascending Cretaceous strata. This same condition occurs in the Bozeman coal-field also, of which the section (Fig. 2, Plate LVI) is distant from that at the mouth of the Yellowstone cañon only about 10 miles (*vide* map of the Bozeman coal-field). On the eastern rim of the Judith basin the core of the Judith mountains, to the south of the mining district of Maiden, consists of the heavy beds of the Carboniferous limestones. Upon these lie conformably the post-Carboniferous rocks, but there is at this point, as also in the slopes of the Moccasins, a decided departure from the series so often observed along the main ranges and the belts mentioned above. The following section **d** represents the series on the Judith mountains just referred to, numbered from below upward. It is taken at a point about 3 miles southwest of Maiden.

	Feet.	
1. Carboniferous limestones, very massive	1,000	
2. Silicious limestones of a light yellow color, gradually changing to	111	
3. Yellow sandstones, weathering red	23	
4. Yellow sandstones, becoming at top very calcareous	92	
5. Slightly silicious limestones, weathering reddish	12	
6. Covered	70	
7. Jurassic limestones, outcrop of	10	
8. Covered	60	
9. Thin, laminated, calcareous shales	6	**e**
10. Limestones; also Jurassic, fossiliferous	21	
11. Shale	49	
12. Sandstones, of alternate heavy-bedded and shaly layers; Cretaceous	70	
13. Gray sandstones, weathering yellow	12	
14. Shales, or very argillaceous and thin laminated sandstones, with upper 20 feet somewhat calcareous	116	
15. Sandstone	6	
16. Ferruginous sandstone, lower 25 feet shaly	35	
17. Ferruginous sandstone	12	
18. Clays, or arenaceous shales	45	
19. Shaly sandstones	35	
20. Lignite, 1½ feet to 3 feet; very poor, dirty, and variable	3	
21. Ferruginous sandstone, rather yellow	32	**f**
22. Ferruginous sandstone	12	
23. Red shales and sandstones interbedded, with one or two limestone strata	420	

It will be observed that the distance between the Carboniferous and Jurassic limestones, about 300 feet, is the same in both this and the section from the Yellowstone cañon, and wherever observed the distance was always approximately the same; but in the section just given the conglomerates at the base of the Cretaceous have disappeared altogether. However, the very decided differences between the Jurassic and Cretaceous strata here enable one to draw the line of union very closely.

The section represented in Fig. 4 (Plate LVI) is from the western slope of the North Moccasin, and is a wide variation from the sections met with elsewhere in our area of explorations. There is no doubt about the underlying limestones (No. 1) being Carboniferous, and probably Nos. 5 and 7 are Jurassic, but the distance between these and

a the Carboniferous limestones is greatly increased over that in other portions of the field. Furthermore, there occurs what are very like granite injections between the strata, but as much of the intermediate space was covered it was impossible to determine definitely their exact character. Notwithstanding this abnormal condition, the base of the Cretaceous is as readily recognized here as in other localities, by its relation to the underlying rocks.

In the region of the Snow mountains, south of the Yellowstone river, the relations between Cretaceous and older rocks differ from the foregoing cases, in that the Snow mountains, in proximity to the coal-field, are faulted up, exposing the limestones to view, and we do not have, therefore, the same succession of strata as elsewhere. Within the mountains, on the Upper Yellowstone river, just above the second cañon, and on the Upper Gallatin above the lower cañon, the usual succession of Jurassic and Cretaceous strata of limestones, sandstones, conglomerates, and overlying shales are met with, and differ in no respect from the typical deposits already b mentioned.

Such, then, are the chief and important characteristics of the rocks underlying the Cretaceous, in reference to their bearing on the identification of one's proximity to the Coal Measures.

As already stated, in the Cretaceous of Montana, there occur at several horizons, from the base to the top, various seams of coal. The Dakota and Laramie groups are the most important in this respect; the Colorado has a few seams of minor importance, while as regards the Fox Hills, none have been discovered that could be absolutely referred to this group. The general character of the Dakota has already been touched upon in connection with the pre-Cretaceous rocks. It is remarkably barren of fossils, but, as is seen in the sections presented, usually consists of heavy-bedded white and yellow sandstones, and conglomerates of a varying coarseness, perfectly conformable with the strata below. The conglomerates are by no means evenly developed, being much c thicker and occurring in more numerous beds in some localities than in others. The thickness of the Dakota was nowhere determined, as our labors were necessarily in another direction, and, moreover, in the vicinity of the main ranges of the Rocky mountains, the transition from it to the overlying Colorado was very gradual and the exact line of junction very obscure. Out of the influence of the shore-line, however, on the prairies, the union, had it been specially observed, would have been very marked, as the lithological characteristics of the Colorado are there very decided. There are one or two peculiarities in the northern part of our field that have not been observed elsewhere in the great rim of the Cretaceous that this group forms along the base of the Rocky mountains and most of its great spurs. These consist in the thin beds of limestone observed in the sections in the Judith basin presented in Figs. 3 and 4, Plate LVI, and in a thin bed of red shales occurring some distance up in the group, at least in the upper half, I should say. The limestones are very silicious, and, so far as observed, are non-fossiliferous. d The red shales, if occurring with a sufficiently gentle dip to cover any extent of surface, are very advantageous to farming, since wherever their materials are washed from the benches formed of them onto the stream bottoms a very productive soil is formed, clearly showing its superiority over the portions of the bottoms not affected by it, in the quantity and quality of the crops. This feature of coloring does not seem to be due to the effects of combustion of coal-beds, as is the case often in the Laramie group, none of the usual results of such phenomena being met with. Neither the limestones or red shales have been seen in any other part of our area of exploration, but form a decided characteristic of the Judith Basin strata. These features have been spoken of in connection with the Dakota, for they seem to have a closer connection with that group than with the Colorado. The important coal-bed of the Judith basin and Belt creek is also referred to the Dakota, by reason of its association with heavy beds of sandstones, which furthermore underlie beds known to belong to the Colorado.

e The Colorado group, comprising the three members, the Fort Benton, the Niobrara, the Fort Pierre, underlies the entire prairie lands in Montana within the border formed by the outcrop of the Dakota. In the valleys of the Yellowstone, Musselshell, and Judith rivers the Fort Pierre alone is usually met with, excepting in the immediate vicinity of the mountains, where, in the Yellowstone and Musselshell valleys, by upheaval and subsequent erosion, it is exposed in connection with the underlying Niobrara and Fort Benton. In the Judith basin proper the lower two divisions of the Colorado are much less prominent, and may be absent altogether, which inference is drawn from the section afforded by the Moccasin mountain on the eastern side of the basin (Fig. 4, Plate LVI) the black shales (Nos. 18–23, inclusive) there given being unmistakably Fort Pierre.

The middle member of the Colorado, the Niobrara, was nowhere in the area of our explorations positively identified. The Fort Benton is typically developed along the Missouri river north and west of the Highwood f mountains, and especially opposite the town of Fort Benton, from which the name of the sub-group is derived. In this vicinity it underlies a large extent of the prairie on both sides of the river. There is also an excellent exposure of the Fort Benton, though slightly different from the typical beds, in the Belt Butte on Belt creek overlying the large coal-seam found there. The section is given in Fig. 6, Plate LVI, as follows: [Numbered from younger to older.]

(1) Sandstone; thin laminated, fine-grained, gray weathering brown.
(2) Sandstone; heavy-bedded, fine-grained, white.
(3) Sandstones and arenaceous clays.
(4) Black shales.
(5) A granitic sandstone.
(6) Shales; very dark blackish-gray.
(7) Sandstone; yellowish-gray, upper 2 feet ferruginous.

(8) Clays; red and yellow.

(9) Clays; red, arenaceous. a

(10) Four interbedded and alternating layers of red and green clays. Layers are of equal thickness.

(11) At the top a concretionary layer of red arenaceous clays, underlaid by 15 feet of greenish-gray sandy clays, these succeeded in turn by more red clays, similar to the upper ones.

(12) Concretionary clays; yellow and drab. Concretions are ferruginous.

(13 and 14) Sandstone; gray. No. 13 is fossiliferous.

(15) Shales; red, purple, and drab, with thin intercalations of drab sandstones. It is separated by 10 feet of gray sandstone from (16)

(16) Shales; red and purple.

(17) Sandstone; moderately fine-grained, white to gray, weathering buff in most places. Upper part usually softer and more pliable than lower numbers. b

(18) Coal. The large seam of this field.

(19 *et seq.*) The section in the southern part of the Judith basin shown in Fig. 3 (same plate) and regarded as Dakota.

The thickness of the strata above the coal, 1,349 feet, would indicate that perhaps much more of the Colorado than the Fort Benton is here exposed. Hayden puts its thickness at 800 feet where typically developed, which fact would place the upper portion of this section in the upper part of the Colorado. The heavy sandstones above might by chance belong to the Fox Hills group.

In other prairie localities than those already mentioned, and especially in the Judith basin proper, the Fort Benton sub-group seems to be far less prominently developed. In the southern part of our area of exploration, near the Bozeman coal-field, it is recognized by its fossils, together with the Niobrara, but lithologically it is totally unidentifiable with the typical Fort Benton of the Missouri river. This distinction between the prairie c beds and those at the eastern base of the Rocky mountains characterizes the entire Colorado group. Where at a distance of a few miles out from the mountains we meet with the dark-gray and black shales and clays so universally characteristic of this group in like positions, along the base of the mountains they are replaced by very arenaceous light-gray and whitish shales, coarsely laminated and interbedded with numerous layers of sandstone from 15 to 70 feet thick. This is particularly noticeable in the section taken at the Bozeman coal-field (Fig. 2, Plate LVI), where the lower members of the Colorado are recognized by their fossils, and also in the strata overlying the section at the head of the Musselshell (Fig. 5, Plate LVI), where the same features predominate. But the Colorado, with its typical characteristics, does occur within the mountainous area, for in the Cretaceous areas on the Upper Yellowstone river, near Cinnabar mountain, and on the Upper Gallatin, above the lower cañon, the dark-blue shales of the Colorado are again met with, underlaid by thin, laminated, arenaceous shales, undoubtedly belonging to the same group, all overlying the Dakota and underlying the upper members of the Cretaceous. d

As these latter localities were comparatively unimportant from an economic point of view, but little attention was paid toward deciphering the complicated problem of the local geology, rendered very difficult by the disturbed condition of the rocks over this entire mountainous country.

The Colorado group is remarkable for the abundance of gypsum occurring in thin scales throughout the strata, especially in the dark deposits of the prairies, while in the vicinity of the mountains, in the more arenaceous beds, it seems to be less abundant. Here, however, the strata that would reasonably be included in this group, especially the shaly sandstones, are calcareous, oftentimes showing a slight effervescence with dilute acid.

The thickness of the Colorado was not measured, but at Billings, by artesian borings made by the Northern Pacific Railroad Company, it is proved for at least 900 feet. e

The Fox Hills group in the region of the mountains was not identified owing to its gradation into both the underlying and overlying members of the Cretaceous. Eastward, in the Yellowstone valley near Billings, and in the Musselshell valley north of the river, and in the Judith basin, 5 or 6 miles west of the Moccasins, it was plainly observed in its bold and unchanging outcrop of heavy beds of white and yellow ferruginous sandstone, overlying the Fort Pierre, the union of the two groups showing finely, owing to their decided lithological differences. Wherever observed it occurs in long, low, but prominent ridges, comprised of a bluff on one side and either a smaller bluff or a gentle slope, generally the latter, on the other, and invariably having its crest-line marked with a growth of stunted pines. The entire group seemed to be rather barren of fossils, but our searches for them were not prosecuted untiringly. Its thickness in Montana is probably a little under 400 feet. The only localities in which a special study of the Laramie group was made were those of the Bull mountains, forming the prominent buttes f northeast of Billings, on the divide between the waters of the Yellowstone and Musselshell and Missouri rivers, and the area between this point and the Snowy mountains, 50 miles northward across the Musselshell. The localities of its occurrence in the northern part of the Judith basin were not visited, and for this section of country reference must be had to the writings of others.

Of the geology of the Laramie, which covers nearly the entire area of the localities referred to, a careful study was made by Mr. Lindgren, of our party, in connection with the general exploration for coal occurring in the Bull mountains, and on Swimming Woman and Careless creeks, north of the Musselshell. Mr. Lindgren's notes are here inserted, with one or two additions by way of comment by the writer.

The first and rather surprising result of the examination is the immense thickness of the Laramie strata. While it was generally supposed till now that the formation had a maximum thickness of from 4,000 to 5,000 feet, (*a*) it is now shown to have a total thickness of

a Geological Exploration of the Fortieth Parallel, vol. I, p. 335.

a about 8,600 feet. The sections on which these conclusions are founded are perfectly continuous, and as far as ascertained, contain no faults, certainly no large ones. Moreover, the difference between the subdivisions in this large series is very distinct and would permit a larger repetition by faulting to be easily discovered.

The sections are—

No. 1. From Big Coulée northward to the Musselshell river and Careless creek, 8 or 9 miles, exposing a small portion of the Fort Pierre, Fox Hills, and the Laramie, to a thickness of 3,000 feet. (Plate LVII.)

No. 2. From the mouth of Swimming Woman creek northward to the Big Snowy mountains, exposing the Fox Hills and 7,800 feet of the Laramie. (Plate LVII.) *a*

No. 3. From Billings northward across the Bull mountains to the Musselshell river, exposing 8,600 feet of the Laramie. (Plate LVIII.) This section is composed of two parts: (*a*) A monoclinal 24 miles long with a constant 3 degrees dip comprising the strata up to the Bull b mountain series, 7,060 feet thick; (*b*) a series of horizontal strata, 1,550 feet thick, comprising the Bull mountain series and extending down to the Musselshell river.

No. 4. (Not drawn.) From the Bull mountains westward along the Musselshell river to Olden, about 19 miles, exposing the Bull mountain series, the Lower Laramie (measuring again 7,000 feet), the Fox Hills, and the Fort Pierre.

If we want to subdivide this enormous series, it must be done with reference to petrographical distinctions, for the fauna of the series remains essentially the same throughout. Precisely the same fossils found at 2,000 feet above the Fox Hills we see again at 7,000 feet above the same. Petrographically, however, the difference between the various parts is very distinct, and they retain their character very well throughout the district. Such a division is very useful, as it greatly facilitates the determinations of the horizons of the different lignite seams found in this formation. The 8,000 feet of Laramie strata divide very naturally into two distinct parts.

1. The Lower Laramie; about 7,000 feet thick, which is easily further subdivided into at least four petrograpically distinct parts. General characteristics: A succession of dark, black, and green clay beds, thin sandstone layers, a few very heavy sandstones, and thin lignite seams. Generally speaking, no valuable lignite beds occur in the Lower Laramie. The upper part shows a rapid succession of c white sandstones and green clay beds.

2. The Upper Laramie, or Bull mountain series, containing the more valuable lignite beds. Thickness, about 1,600 feet, characterized by a succession of light-colored clays, white, soft, argillaceous, sandstones, and heavy benches, of a thickness of from 10 to 30 feet, of yellow massive sandstone, with rounded corners and faces, and generally carrying round nodules of brown iron ore. Abundant fossil leaves, and plant remains generally.

Before beginning to discuss the different parts of the formation, a few words may be said about the fossils.

Fauna.—As before remarked, the fossils from nearly all parts of the formation indicate a deposit in fresh and brackish water. The same or similar fossils occur in very widely-separated parts of the series and consist mainly of fresh-water gasteropods, and fresh- and brackish-water bivalves, such as Ostrea, Corbula, Corbicula, Anomia, Unio, Helix, Physa, Bulinus, and Goniobasis. A few of the Gasteropods belong, according to Mr. R. P. Whitfield, to new species. A few indistinct vertebral remains were found in the clays some hundred feet above the Fox Hills sandstones.

In the Swimming Woman creek section (Plate LVII) there is a most remarkable exception to the general rule. As it may be seen from the section the Fox Hills sandstone is exposed near the mouth of Swimming Woman creek; 5 miles farther up, 2,350 feet vertically, above d the Fox Hills, are the coal-beds of Swimming Woman, surrounded by fresh-water clays.(*b*) Fifty feet above the coal and 120 feet below, a rather heavy white sandstone with Ostrea glabra, Corbula and Corbicula, a calcareous sandy layer was found by Mr. Eldridge, containing a perfect Placentaceras placenta, var. intercalaris M., a Baculites, young specimen, and a Mactra Warrenana. These are all purely marine forms, indicating Fort Pierre or Fox Hills. A fault is hardly possible, for the general sequence of the layers coincides very well with that of the other sections, and the conspicuous Fox Hills would certainly have been seen if repeated above the mouth of the creek. The only plausible explanation is that a temporary influx of marine water with marine forms took place in the brackish Laramie sea. The case is of very great importance as showing that, during the deposition of the Laramie, the Cretaceous marine forms had by no means yet disappeared, and, consequently, proving the Cretaceous age for at least the lower part of the Laramie.

Flora.—Plant remains are found throughout the series, but most abundantly in the upper part.

Lower Laramie, No. 1.—Thickness about 1,200 feet. It is composed of dark, often quite black, soft, and crumbling fresh-water clays, very different from the dark shales of the Fort Pierre. Nowhere did I succeed in finding any distinct fossils. Sometimes thin sheets of harder sandstone are intercalated. Wherever this series is exposed it has a tendency to form "bad lands." Near Billings, it is well e exposed on the south side of the Yellowstone in the Crow reservation. The sequence of the Fort Pierre, Fox Hills, and Laramie is beautifully seen from the bluffs on the north side of the river. Another very good exposure is on Painted Robe creek, some miles south of the Musselshell river. It here forms bluffs of black clay 300 feet high, and in the wider part contains the worthless lignite of Painted Robe. This is geologically the lowest coal in the region, 400 feet or 500 feet above the Fox Hills. The corresponding strata also crop out around Big Coulée and on Swimming Woman creek. These clay-beds are always covered by a hard, slaty sandstone, sometimes with peculiarly twisted and oblique lamination. It is seen on Five-mile creek, near Billings, and on Painted Robe creek.

No. 2. At about 1,700 feet above the Fox Hills group a very remarkable heavy sandstone occurs; it is about 200 feet thick, heavy-bedded, massive, and yellow, and has the peculiarity of cropping out even on the level plateaus in sharp peaks and rugged outlines. Well exposed 7 miles north of Billings, the sharp peaks are seen from far away. It is also well exposed beyond the black clays at Painted Robe and on the southern side of the Musselshell opposite the mouth of Careless creek.

No. 3. The next portion, about 600 or 700 feet thick, is a succession of dark, soft, sandstones, black clay beds, thin white sandstones, and worthless lignite beds. It comes a short distance above the sandstone of No. 2, and forms dark bluffs with a tendency to the formation f of "bad lands." It is very well exposed at the mouth of Careless creek in dark bluffs capped by vermilion-colored sandstone, resulting from the burning out of some lignite seam. The same series is exposed in Spring butte north of Billings. In the dark clays at the mouth of Careless creek there are found plants, fruits, a large Sphærium, Goniobasis, and Bulinus. Closely above this group we have the coal of Careless creek immediately covered by a perfect oyster-bank containing also chips of coal. The fossils found in this bank are Ostrea

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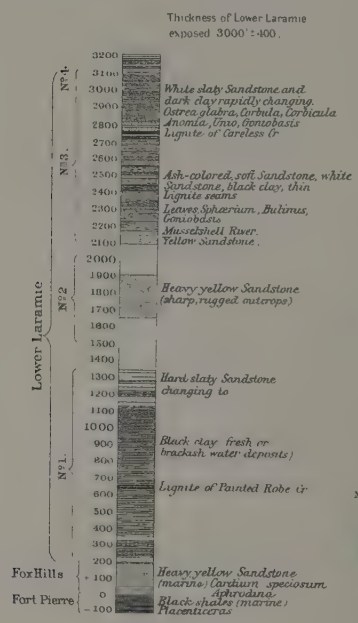
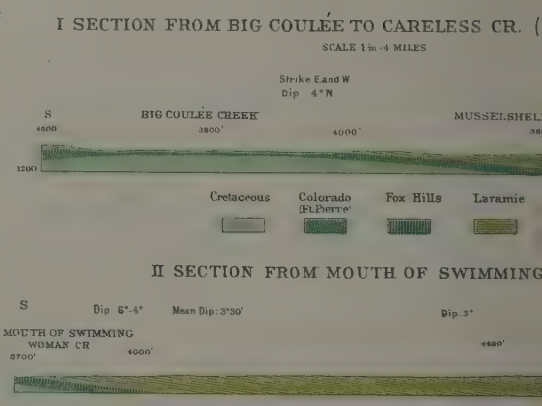
a Mr. Lindgren states elsewhere that his horizontal distances in passing over the Swimming Woman section were in part estimated. A previous casual examination, in which the distances were all paced or measured, was made by the writer, and his results give to this section a thickness of 6,570 feet, necessarily the more correct. [Eldridge.]

b The overestimation referred to in the above note, of the thickness of the Swimming Woman section of Mr. Lindgren, seems to lie at the base of the series, for the coal lies at the most only 1,000 feet up in the Laramie, if the sandstones at the mouth of the Swimming Woman are indeed Fox Hills, instead of 2,350 feet as stated in the text above. This decrease in the thickness would also very closely harmonize the sections of Mr. Lindgren and myself. Regarding the thickness of the Lower Laramie elsewhere, Mr. Lindgren's sections are taken as the authority. [Eldridge.]

SECTION FROM BIG COULÉE TO CARELESS CR.



From top of Fox Hill Sandstone to end of series on Careless Cr S. 2 miles, Dip 4. Thickness per mile 5280 × sin. 4° = 5280 × 0.070 = 370'. Consequently thickness exposed of Lower Laramie 370' × 8.2 = 3034'.



By Waldemar L

From unpublished M.S. material of the Northern Transcontinental Survey.

MT. MAP)

N
3700'

above the level of the sea

AN CREEK TO SNOWY MTS.

BIG SNOWY MOUNTAINS

Dip: 3°30'

Dip uncertain
6000'

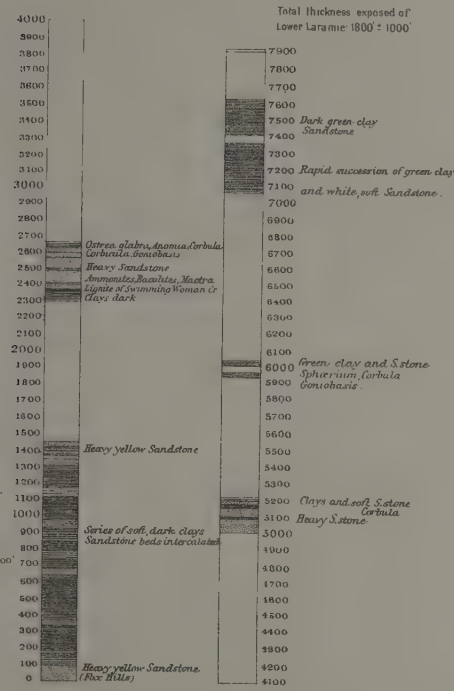
Dip flat
8600'

8600'

2000'

1884.

SECTION ALONG SWIMMING WOMAN CREEK.



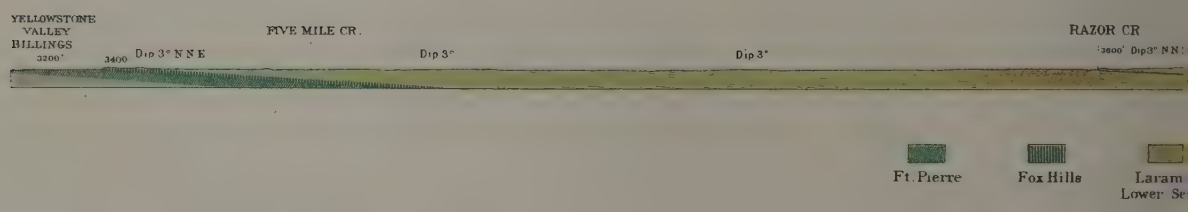
From mouth of Creek to Coalbed. 5 miles. Average dip 4°30'. Difference in height about 280'. 5280 × sin. 4°30' = 5280 × 0.078 = 414' per mile. Total 414 × 5 = 280 = 2350'. From Coalbed to base of Mountains 14.5 miles. Difference in height 1620'. Average dip 3° (low average: dip 4° to 2°3°). 5280 × sin. 3° = 5280 × 0.052 = 270' per mile. Total 270 × 14 × 5 = 1620 = 5550. Total thickness of Laramie (Lower series) 2350 + 5550 = 7900.

Julius Bien & Co Lith

SECTION FROM THE YELLOWSTONE RIVER ACROS

By Waldema

SCALE: 1

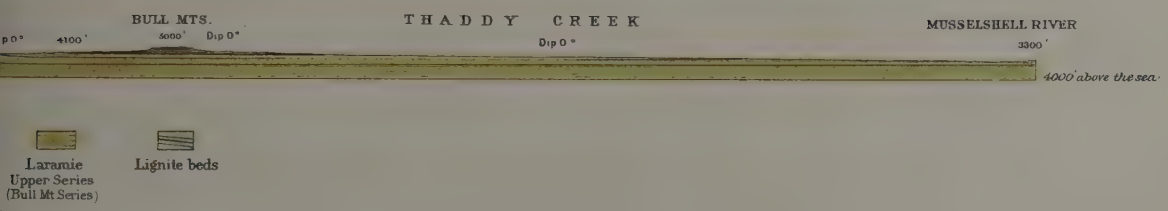


From unpublished MS. material of the Northern Transcontinental Survey.

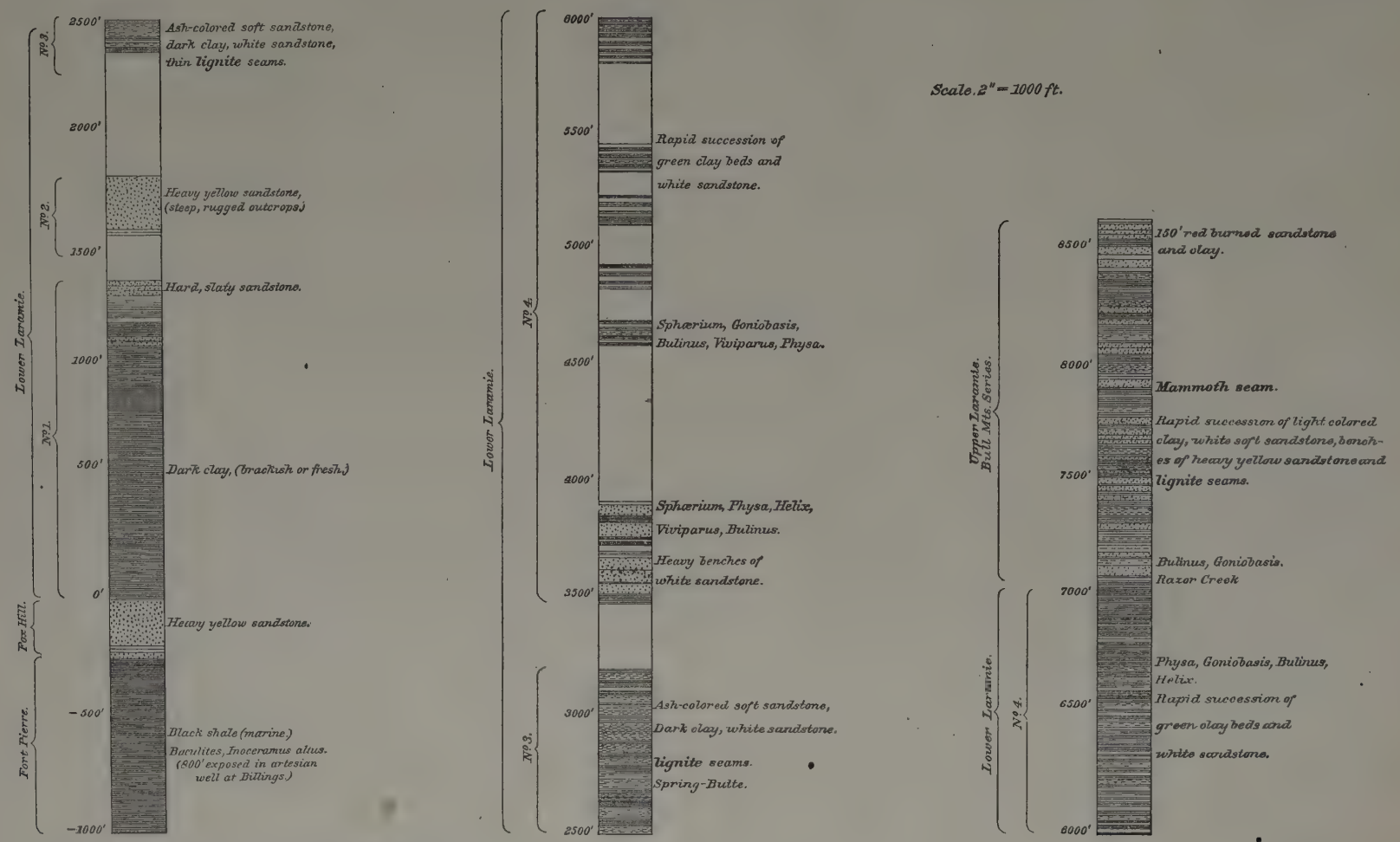
HE BULL MTS. TO THE MUSSELSHELL RIVER,

ren, 1884.

MILES



Julius Bien & Co Lith



From unpublished MS. material of the Northern Transcontinental Survey.

SECTION OF THE LARAMIE GROUP, IN THE REGION OF BULL MOUNTAIN, MONTANA.

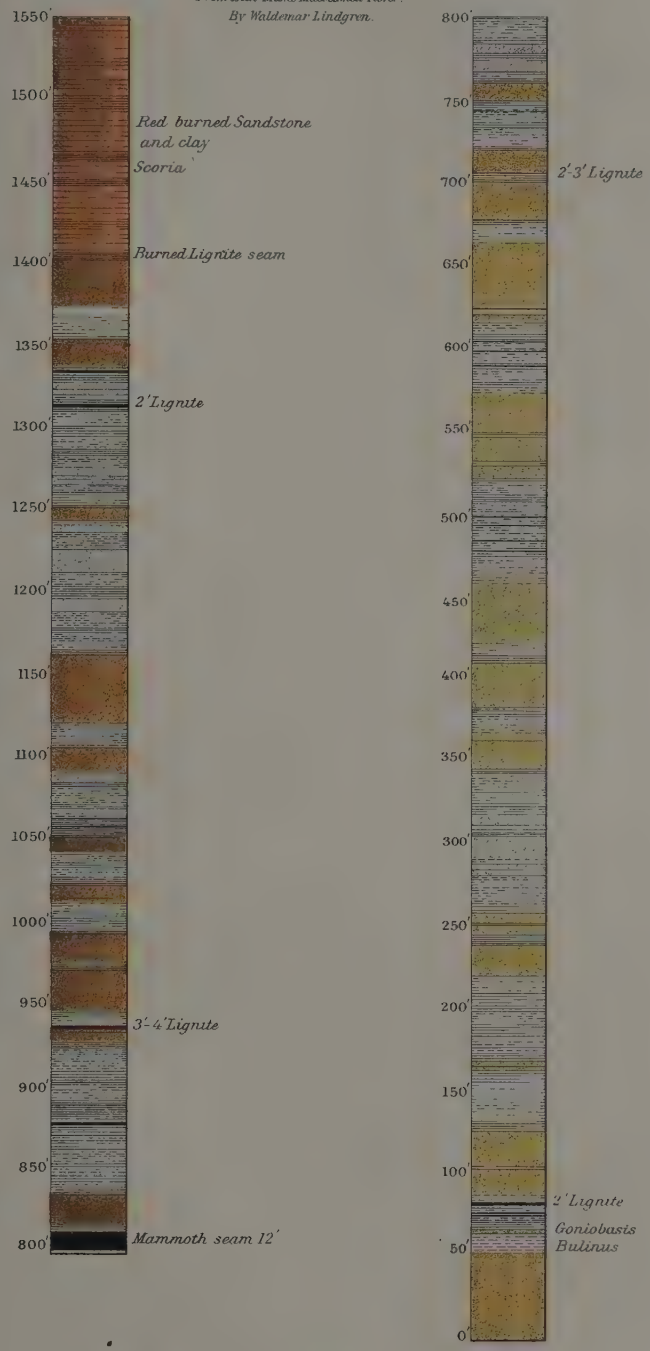
COMPLETE SECTION OF THE

BULL MT. SERIES

(UPPER LARAMIE)

TOTAL THICKNESS: 1550 FT.± 100 FT.

From Bull Mts. to Musselshell River.
By Waldemar Lindgren.

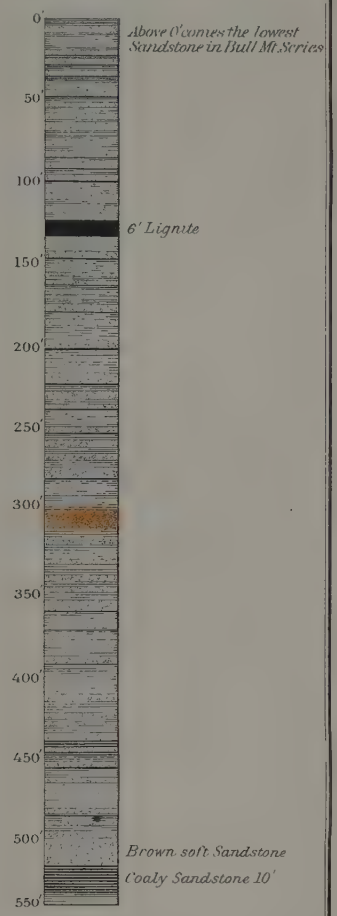


SECTION OF

LOWER LARAMIE SERIES

(HIGHEST PART)

From mouth of Wildhorse Cr. (Musselshell River)
By Waldemar Lindgren.



Yellow heavy Sandstone in rounded benches

White slaty Sandstone

Argillaceous Sandstone

Clay and marl
Gray and light colored in Bull Mt. Series; Green in Wildhorse Section

Lignite seams

From unpublished MS. material of the Northern Transcontinental Survey.

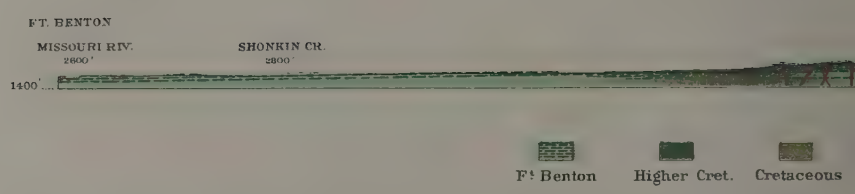
Julius Bien & Co. Lith.

W. Lindgren del.

SECTION OF THE HIGHWO

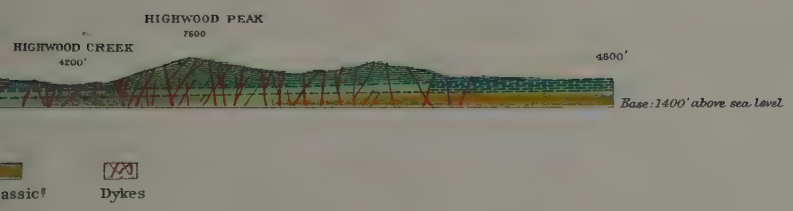
By Waldemar Lindgren, 188

SCALE: 1 in.= 4 MILES



From unpublished MS. material of the Northern Transcontinental Survey.

MOUNTAINS.



Julius Bien & Co. Lith.

glabra, M. & H.; Anomia micronema, M. & H.; Anomia gryphorynchus, White; Corbicula cytheriformis, M. & H.; Corbula perundata, a
H.; Unio Conesii, M. & H.; Melania or Goniobasis, and above the coal on Swimming Woman creek there is a rather heavy-bedded white sandstone with Ostrea glabra, M. & H.; Anomia micronema, M. & H.; Anomia gryphorynchus, White; Volsella laticostata, White; Corbula subtrigonalis, M. & H.; Corbicula cytheriformis, M. & H., and Goniobasis. (*a*)

No. 4. The lowest part of this series seems to be characterized by some heavier white sandstones (12 miles from Billings) in which Sphærium subellipticum, M. & H.; Bulinus longiusculus, M. & H.; Physa Bridgerensis, Meek; Viviparus Conradi, M. & H., and Helix vetusta? M. & H., were found. The upper part, comprising a series of about 3,000 feet, is a rapidly varying succession of white sandstones and green clays. The appearance of this part on the plateau between Billings and the Bull mountains is very uniform. A series of small ledges of the harder white sandstone, generally weathered brown, protruding as low reefs, the soft clay beds being eroded and leveled. Sometimes a heavier bench of the same sandstone appears. The green clay between the sandstone strata is well exposed in the numerous dry, broad gulches which the creeks have cut in the level plateau. Numerous fossils were found in the clays in the Billings series—Sphærium formosum, M. & H.; Goniobasis tenuicarinata, M. & H.; Goniobasis Endlichi, White; Bulinus longiusculus, M. & H.; Viviparus Conradi, M. & H.; Physa felix, White, ? and Helix. In the Swimming Woman Creek series, in the sandstone, Corbula subtrigonalis, M. b
& H., and in the clay and near the mountains, plants, fruits, Sphærium formosum, M. & H.; Sphærium subellipticum, M. & H.; Corbula undifera, M. & H.; Goniobasis tenuicarinata, M. & H.; Tulotoma Thompsoni, White, and Colcmeateres, M. & H.?

The uppermost part of No. 4, just below the Bull Mountain series, represented on a larger scale in the section of the latter, shows some peculiarities. Thin lignite seams here abound. Several layers of a sandy coal or coaly sandstone, from 1 foot to 10 feet thick, and not found elsewhere, appear. Above these coaly layers we generally find a deep brown, very soft, argillaceous sandstone. This is seen on Razor creek, on the road from Billings; at the mouth of Wildhorse creek, where we find a disturbance with 6° to 8° dip, just beyond the horizontal Bull Mountain series; farther up on the Musselshell, at the mouth of Golden creek; and equally 3 miles eastward again at the mouth of Denis creek. At the last place the coaly sandstones come approximately 700 or 800 feet below the Bull Mountain series, and, furthermore, sometimes change into streaks of pure coal, alternating with sandy layers, but never having a predominance of the coaly layers sufficient to be of economic value, except, perhaps, locally.

About 100 feet below the last heavy sandstones of the Bull Mountain series some more important lignite seams are found. At the c
mouth of Wildhorse creek is a seam 6 feet thick, of good quality, but thinning out laterally or separating, for at Fisher creek, farther down the Musselshell, we find, just below the sandstone, two seams of 2 feet each, and still lower, 3 miles up Fisher creek, a bed of 3 feet 2 inches. I am not, however, quite certain of the position of the last-mentioned coal. At Razor creek, all thicker seams have disappeared or thinned out.

UPPER LARAMIE (BULL MOUNTAIN SERIES).

The upper part of the Laramie, occupying the center of the district, that is, the high mesa and surrounding hilly and wooded country, is a well-defined and distinct series. The map (Plate LXIX) shows its extension by the run of the lowest sandstone bench, a conspicuous bed of yellow sandstone, 50 feet thick, presenting a mural face, seen for a long distance of about 30 miles, near the Musselshell river, and also well exposed where the road from Billings crosses Razor creek. The thickness of the series, measured repeatedly from the top of the Bull mountains down to the Musselshell, and to Razor creek is nearly 1,550 feet; the largest lignite seam of the Bull mountains being found in the middle part of the series. Lignite beds are found in great numbers, although by far the most of them are practically without any d
value. The character of the series is shown in the section of the Bull Mountain strata. It is a rapid succession of light-gray and grayish-green clay-beds, white argillaceous sandstones, numerous thin lignite seams, and 10-foot to 30-foot benches of yellow, massive sandstone in rounded outcrops. These sandstones often contain numerous small, rounded concretions of brown iron ore. The clays become somewhat darker near the bottom of the series. Numerous sections were uncovered in different parts of the mountains, all showing a great constancy in the sandstone benches. Indeed, the most important of these can be traced all around the mountains. The highest white sandstone bench is capped by brick-red layers, sometimes attaining a thickness of 150 feet, of hardened yellow and red sandstone, purple, black, and brick-red fritted clay, perfectly jasper-like, with sometimes a layer of black, porous scoria. The above peculiarities are undoubtedly due to the burning of a large lignite seam near the summit of the mountains. Thus the section given is a general one. The distribution of the coal-seams may best be seen by reference to the section (Plate LX).

Flora.—The whole series is very rich in impressions of leaves and other vegetable remains, the clay-beds especially abounding in them. Leaf impressions are found all through the Laramie, but nowhere in such number as in the upper series.

The *fauna* i sexceedingly scarce. Above the Mammoth seam no animal remains were found, in spite of very close examination. I e
am told, though, that two gasteropods have been found in the mines of the Northern Pacific Coal Company. No trace of brackish-water bivalves could be found in the sandstones. Seven hundred and fifty feet below the Mammoth seam I succeeded in finding a Bulinus subelongatus, M. & H., and a Goniobasis tenuicarinata, M. & H.

It is clear that, in a series of such a thickness and extent as the Laramie, the results necessarily must show several gaps and the accuracy be limited, especially as the calculations are based on slight dips, not to be measured with less probable error than 30 minutes. However, I do not believe the inaccuracy to be greater than estimated at each calculation.

In connection with the Cretaceous strata of Montana there are two other localities worthy of special note—that of the Highwood mountains (Plate LXI), in the north, and that of the Crazy mountains, in the south, a short distance northeast of the Bozeman coal-field. The former mountains attain an altitude above sea-level of 7,604 feet, and above the prairies at their base of 3,000 feet. The latter range attains an altitude above sea-level of 11,178, and above the prairies at their base of 6,000 feet. Both ranges are made up of horizontal strata of chocolate, gray, and white sandstones, and a few thin-bedded, fine conglomerates. Evidently these ranges are far above all of our known coal horizons in the immediate vicinity of the Rocky mountains, and therefore will be found to be either Upper Cretaceous or f
Tertiary. They have been preserved from erosion by reason of their being traversed by innumerable dikes, occurring in close proximity to each other, which, here and there, slightly alter the sandstones, especially next the line of contact. The dikes are not only vertical,

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a Owing to Mr. Lindgren's overestimation in the lower part of the Laramie, a note of explanation is here also needed. (1) The coal on Swimming Woman creek and Careless creek is undoubtedly at the same horizon. (2) It would therefore come lower down in the Lower Laramie series than is assigned by Mr. Lindgren on the preceding page, unless a thickening of the underlying beds had occurred in the area from which the section between Billings and Bull mountains was taken. Since Mr. Lindgren places the strata at the mouth of Careless creek in his No. 3, Lower Laramie, the argument is that the measures below the coal must be thickened in the area just mentioned above, for the Careless creek coal comes only about 300 feet above that part of No. 3 exposed at the water-level at the mouth of Careless creek. The only other alternative by which this coal can occupy this position in No. 3 is that Mr. Lindgren may be mistaken in assigning the sandstones at the mouth of Swimming Woman to the Fox Hills. They may indeed come higher up. [Eldridge.]

a or at high dips, but also extend in floors between the sandstone strata, and thus, by their own hard texture and that which they have imparted to the strata through which they have passed, have enabled these lofty ranges to resist the erosive powers which have held sway on all sides since the elevation of the lands from beneath the Cretaceous and Tertiary seas. In a few instances only do the dikes extend outward onto the prairies, and then for but a few miles, say from 5 to 15. Here and there also do we find a dike cutting the prairies or mountains many miles apart from any of the great areas of eruptive phenomena.

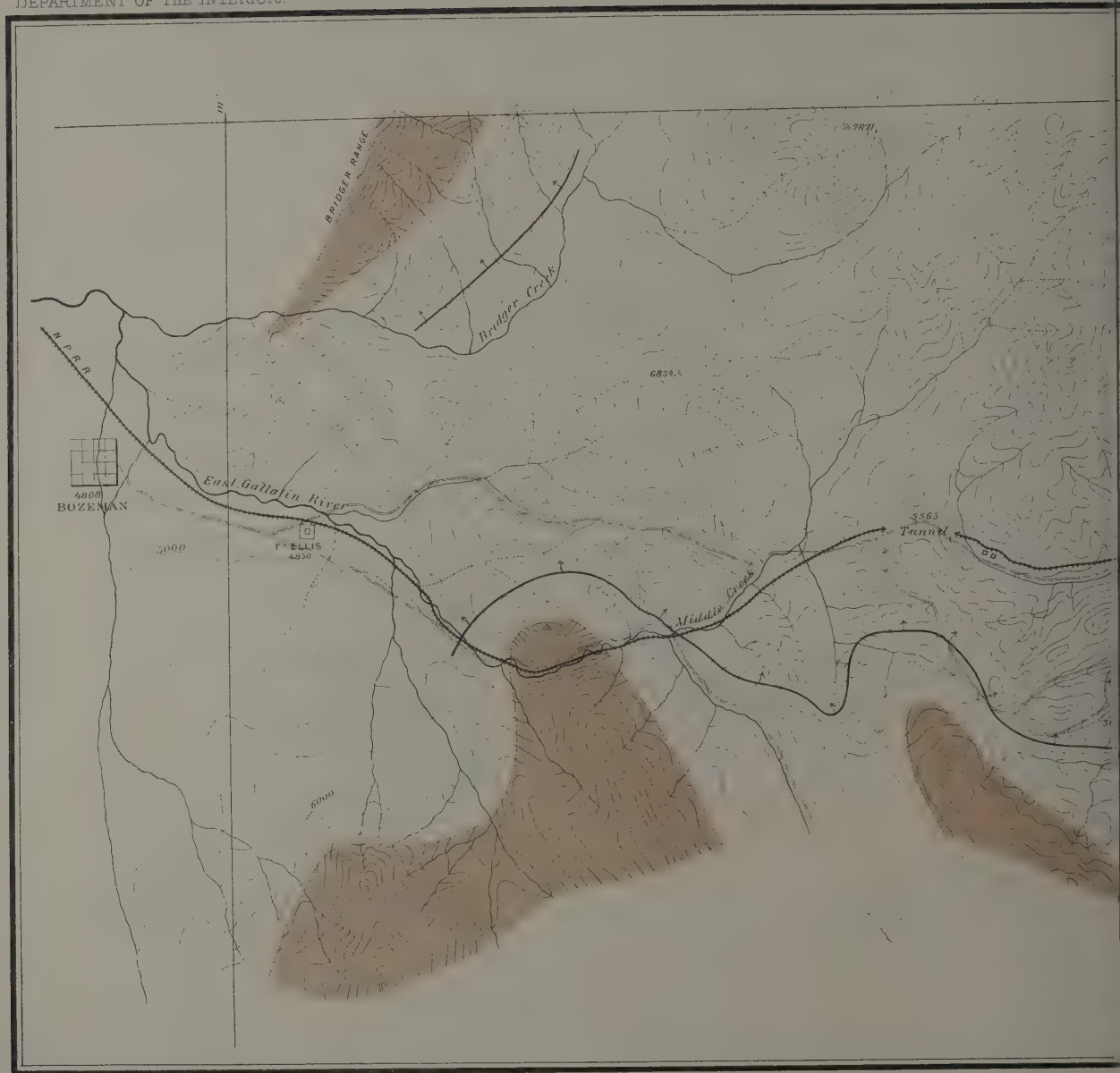
Finally, from our explorations, we draw the following conclusions as to the least probable thickness of the Cretaceous of the prairies of Montana. From the section given in Fig. 6 (Plate LVI), which includes that of Fig. 3. if we regard as Dakota all below the top of the first sandstone above the coal on Belt creek (No. 17 of the figure), we have a thickness for this lower group of the Cretaceous of 860 feet. In Fig. 4 (on the same plate) we have a thickness of at least 1,800 feet for the Colorado, which is clearly overlaid by 400 feet of the Fox Hills sandstones b as exhibited in a prominent bluff a few miles west of the North Moccasin in the Judith basin. From Mr. Lindgren's explorations we are led to assign 8,600 feet as the thickness of the Laramie group, which together give a total thickness for the Cretaceous of 11,660 feet.

THE BOZEMAN COAL-FIELD.

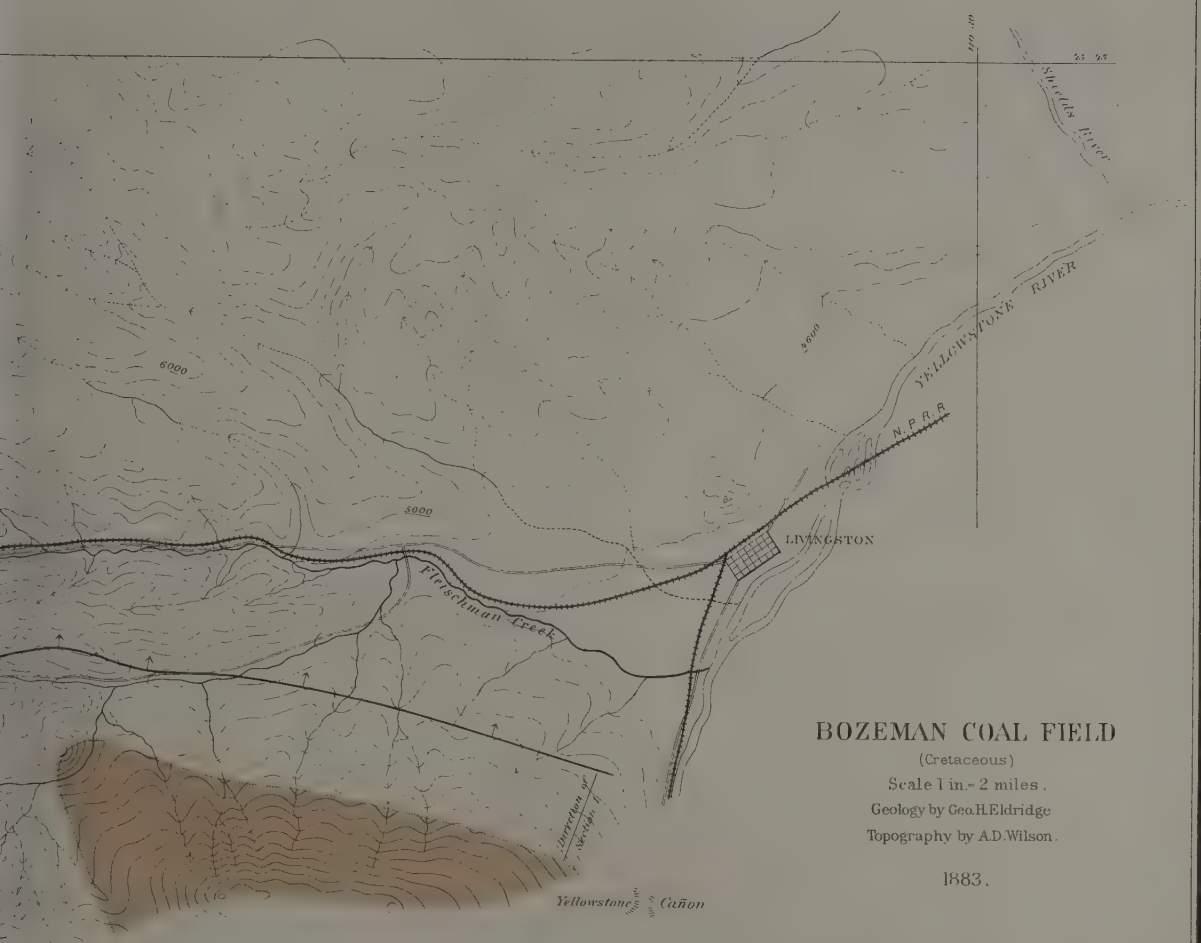
This field lies in the midst of the Belt range, 12 miles east of Bozeman, the leading town of the extensive and most fertile Gallatin valley. The Belt range here forms the divide between the waters of the Yellowstone and Missouri rivers, and is constituted of two subordinate ranges, (1) the Bridger and its continuation southward, the Bozeman range, fronting on the Gallatin valley and forming its eastern wall, and (2) the much lower main range c proper just east of the meridian of 110° 45′, with its continuation in the mountains which border the Yellowstone river on the west, and finally cross and find their fellows in the lofty Yellowstone range south and east of the river It is this second range that contains the low Bozeman pass, only 5,565 feet above sea-level, and 800 feet above the Yellowstone and East Gallatin rivers, over which the Northern Pacific railroad passes on to the Upper Missouri river after its long course up the Yellowstone. The interior basin formed in this manner by the two parallel subordinate ranges mentioned is drained by numerous small creeks of the clearest water, the chief being Bridger creek, along the eastern base of the Bridger mountains, and Middle creek, heading against the Bozeman pass, and having its outlet into the East Gallatin through the wild and picturesque Rock cañon. On the eastern slope of the main range we have but one important creek, within the area of our map, called locally Fleischman creek, receiving numerous small tributaries from the mountains south of it, but few from the hills at the north. At the d northeast extremity of our map (Plate LXII) lies the mouth of Shields river, draining the wide valley between the main Belt range and the lofty Crazy mountains farther east.

There is nothing intricate in the general geology of the Bozeman coal-field. In the southern part we have three anticlinal folds, which as the effects of erosion, have exposed on their flanks the pre-Cretaceous rocks, indicated by the colored portions on the map. Their axes lie normally a little west of north, with a downward curve at their northwest extremities, but in the easternmost anticlinal another influence has been brought to bear, causing its axis 2 miles south of its northern end to be deflected to the eastward, which strike then continues with minor unimportant curves across the Yellowstone river for at least 30 miles. The westernmost anticlinal is also connected with other folds to the southwestward which join it to the high ranges forming the southern wall of the Gallatin valley. As these did not promise good results in the way of coal explorations, their geology was left unstudied e for more immediately important fields. A peculiar feature of all these anticlinals is their ends being cut by deeply eroded cañons, not one of the leading upheavals escaping. The influence of these folds, with their inclined axes at their northern ends, and their subsequent erosion, upon the line of outcrop of the successive strata may be seen in the line of outcrop of the coal as represented on the map. In the northwestern corner of our map we have one other pre-Cretaceous area, that of the Bridger mountains, which are an enormous overthrow with a reversed dip to the westward, the older measures lying on top of the younger. The line of coal outcrop is approximately represented with its dip in toward the mountains. A short distance farther out from the range, toward the southeast, we find the rocks normally dipping to the southeast. In the eastern portion of the map area the folds are more numerous, but of minor importance and very gentle, with a general direction west of Shields' river to the westward. A few miles beyond the northern limit of our map the disturbances have been much more irregular and less studied, as f but slight exploration proved them practically worthless for coal deposits. There is, however, a connection with the geology of our region in a gentle southerly dip over a small area and away from the influences of more powerful disturbances northward. From what has been said, we now see that the Bozeman coal deposits occupy a large synclinal basin, oftentimes covered with from 3,000 to 4,000 feet and more of superimposed Cretaceous strata, as is well represented in the high hill constituting a geological outlier cut by the meridian of 110° 45′, and lying just north of the Northern Pacific railroad, and also in another similar eminence west of this in 110° 52½′.

The only important development of coal lies along the southern edge of this synclinal basin, becoming quickly covered in its high dip of 45° and over by an enormous thickness of strata rendering it unavailable for mining beyond a certain depth, however valuable it may be. This vein of coal undoubtedly connects with that just southeast of the Bridger, and again appears in unimportant seams in the region just beyond the northern limit of the map.



From unpublished MS. material of the Northern Transcontinental Survey.



BOZEMAN COAL FIELD

(Cretaceous)

Scale 1 in.= 2 miles.

Geology by Geo. H. Eldridge

Topography by A.D. Wilson.

1883.

The heavy black lines indicate the outcrops of the coal-bearing strata. The arrows show the direction of dip. The areas of Palæozoic rocks are tinted. The untinted parts of the map are covered with strata younger than the Palæozoic.

Julius Bien & Co. Lith.

Referring, now, to Fig. 2 of our plate of geological cross-sections (Plate LVI), we find here represented the chief stratigraphical features of the rocks occurring in the coal-field. We have represented at the base of the Cretaceous the Jurassic limestones, No. 6 of the figure. Immediately overlying these, and perfectly conformable, comes the basal conglomerate of the Dakota in the figure. a

(7) A very massive conglomerate passing through (8) a transition bed to (9) a fine-grained sandstone.
(10) Covered, but undoubtedly a sandstone like (9), perhaps more shaly.
(11) A very massive, fine-grained millstone grit.
(12) Covered.
(13) A fine white sandstone.

From here upward to the coal we have at various horizons prominent outcrops of sandstones very much like No. 13, portions of the same or different layers, perhaps, containing a little more iron than others, as shown by the yellow and rusty weathering. Interbedded with these sandstones, and forming by far the larger part of the Cretaceous strata, are the characteristic shaly sandstones, very thinly laminated and usually uniformly breaking down under the weather, unless by chance the arenaceous constituents of the rock happen to be somewhat in excess of the usual amount or the argillaceous portion below the average amount usually present. Wherever this is the case we are liable to find a reef of sandstone standing out for a distance of from a few feet to half a mile. Midst these shales, and the heavier-bedded sandstones also, there appear to be layers decidedly calcareous, even effervescing with dilute acid, but, nevertheless, true fine-grained sandstones. As we approach the horizon of the coal we meet at about 600 feet below it a sandstone (No. 22 of the figure) forming a very prominent bluff in the eastern part of our field, but which in the western part, across the divide, has changed to one of the thin laminated variety, and no longer shows as a distinct outcrop. The sandstone, No. 24, just below the lower seam, acts in the same manner, and not until we come to the sandstone immediately underlying the principal bed do we find any persistency in the behavior of the strata in this particular. b c

Near the horizon of No. 14 or 16, probably the former, numerous fossils, characteristic of the Fort Benton and Niobrara divisions of the Colorado, were found by Mr. W. M. Davis. They were—

Inoceramus umbonatus, M. & H.
Inoceramus problematicus, M. & H.
Inoceramus, sp.? fragment of large sp.
Inoceramus undabundus, M. & H.
Ostrea congesta, Con. d
Ostrea strigilecula.
Ostrea, or possibly
Gryphæa vesicularis, M. & H.; cast only.
Gryphæa, sp.? This is what Meek called *P. vesicularis*. It is probably an undescribed species, as it does not seem to be vesiculose.
Gryphæa, sp.? shell resembling *Mactra Siouxensis*, Meek.
Exogyra, sp., possibly young of *Ex. costata.*
Gyrodes depressa, Conrad.
Naticopsis (gyrodes) depressa, M. & H.
Panopea, or *Glycimeris*, sp.? too indistinct.
Glycimeris, Berthoudi, White.
Pinna Lakesi?
Pteria, sp., *P. linguiformis*, sp.? perhaps new. e
Pteria, sp.?
Pholadomya Berthoudi, White.
Cast of *Gasteropod* like *Turritella.*

Mr. Whitfield makes the remark that "the Cretaceous fossils are apparently all from a single horizon, and would be classed as No. 2", (Fort Benton) generally, although they partake somewhat of No. 3 (Niobrara), so that I am inclined to think that both horizons are here blended together.

About 50 feet above the principal coal-bed we find a heavy bed of white sandstone showing an outcrop of 20 feet in thickness, though in places broken down and disappearing altogether. At No. 29 in the figure there is a small outcrop of a chocolate-colored conglomerate, and indeed from here upward we find thin beds of conglomerate of fine composition, interstratified with coarse sandstones of the same color, with here and there in the series the usual gray and ferruginous sandstones similar to those occurring below the coal, the latter at times shaly and very argillaceous, and at times forming bold outcrops 30 to 50 feet wide. f

The sandstone No. 30, about 400 feet above the coal, is usually exceedingly characteristic and persistent throughout the entire field, forming the first prominent and high ridge above the coal. It is of a dark chocolate color, rather coarse-grained, oftentimes containing small pebbles of the size of a French pea, very hard, and breaks uniformly into small and very sharp angular fragments of an inch or two in diameter, and usually forms a broken-down but prominent outcrop of fine pieces, strewn over a width of 30 feet or so, upon which very little vegetation grows—mostly cactus, a few tufts of bunch-grass, and a few low-flowering plants. It consists largely of volcanic materials. It is most peculiar, is easily recognized, and has the appearance at times of having undergone the early stages of metamorphism, though the cause still remains undiscovered. No. 32 is a fine-

a grained yellow sandstone overlaid by more shaly varieties. Above this, even to the summit of the high outlier on the meridian, north of the railroad, comes a succession of arenaceous shales, gray and ferruginous sandstones, weathering yellow, and forming numerous reefs of rocks in the ascent of the hill, and interbedded with these every now and then we find the dark chocolate, coarse sandstone, much harder than that of any other variety, and invariably forming bold combs, while at several horizons are to be found local beds of conglomerate with pebbles, from the size of a walnut down. As we reach the summit of all these outliers, the rocks are naturally more horizontal and across the synclinals are seen the same strata having an opposite dip.

The section taken at the lower cañon of the Yellowstone (Fig. 1, Plate LVI) may also be taken as representative of the coal-bearing Cretaceous strata, though outside of the limit of the field proper, which embraces only such b an area as covers the paying portions of the coal-beds. In this section the coal has been found near the horizon of No. 30, and crosses the river and continues eastward at about the same distance from the limestones of the Jurassic. It is observed that much of the upper portion of this section was covered, but the unfilled spaces are undoubtedly occupied by the arenaceous shales seen in the section of the coal-field proper.

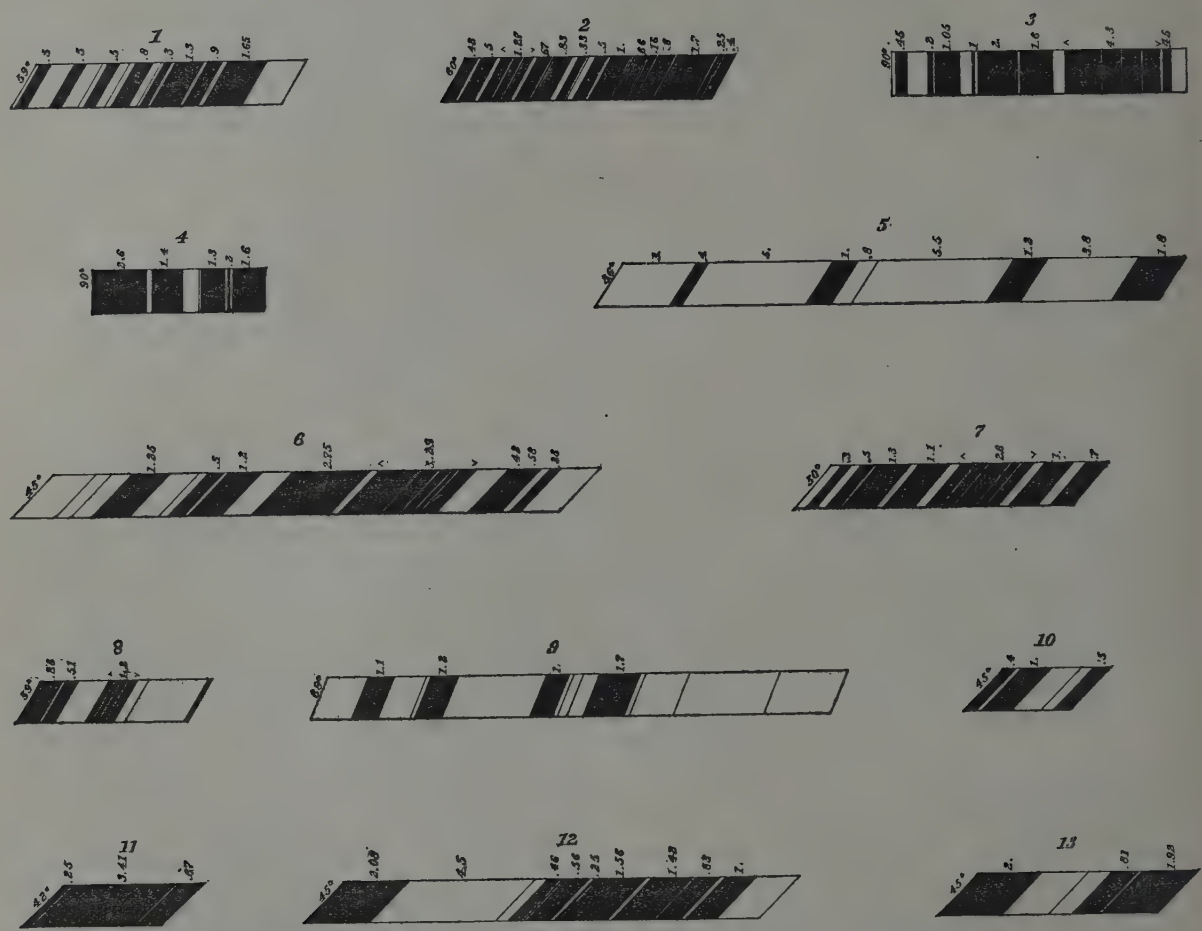
The strata in the vicinity of the Bridger range were too broken to admit of a valuable section being secured toward the determination of the horizon of the coal. In general, the succession and lithological characteristics of the beds were the same as met with in the Bozeman field proper. There are to be found at several points throughout the area covered by the map dikes of eruptive rock, of never more than from one-quarter to one-half a mile in extent and usually under 6 feet in thickness. They have not given rise to any serious displacement, though faults c having a small throw occur at other points, to be noted beyond, but without any accompanying eruptive rock

The coal-seams.—In the Bozeman field there are three distinct beds of coal of noticeable size, with several insignificant layers of an inch or two, occurring in the midst of a brown argillaceous shale, containing an abundance of impressions of deciduous leaves. Of the more important ones the upper two, styled the A and B seams, will best be considered first, and, as they are separated from each other by only a few feet (from 10 to 15 feet) of interposed rock, they have been indicated on the map by the single continuous line. The outcrop of the seam pursues a very irregular line from the Yellowstone to the East Gallatin, bending around the depressed northern ends of the three anticlinal axes and extending well into the intervening and elevated ends of the two corresponding synclinal basins. Just south of the westernmost synclinal basin, and barely touching the map limits, on the road to the Yellowstone river via Trail creek, the field is continued in a small synclinal remnant of the original deposit, separated from its fellow north of it by reason of the inclination of its own axis in the opposite direction to the one d at the north, and a subsequent erosion of the strata to a depth sufficient to carry away the entire coal-beds for a distance of 3 or 4 miles between the two areas. This second area, which may be called the Trail Creek field, is of too small extent for large enterprises, is much pressed into subordinate folds, and is in a position accessible to a railroad only at the considerable expense always accompanying the overcoming of steep grades. The nature of the coal is precisely that of the Bozeman field, and hence it will be hereafter referred to only casually. In addition to the greater curves of outcrop due to erosion of upturned strata, there are many minor ones, which are the result of actual crumpling of the strata by forces acting laterally, but only in two cases was actual faulting observed. In one of these, on the northeastern dip of the western anticlinal, the throw is between 200 and 300 feet, while in the other, on the eastern side of the middle anticlinal, the throw is but 30 or 40 feet. Generally these subordinate curves are of too small extent to permit of representation on the scale adopted for the map.

e The dip of the beds varies throughout the field. In a general way, east of the range it is from 37° to 45°, and west of the range it varies from 57° to 80°; the folds being more abrupt and frequent. This field has been prospected by pits and tunnels quite extensively, and it is found that while the general dip remains as described, the beds are subject to slight variations in depth in all parts, and, of course, also where the strata contain minor folds caused by gentle lateral thrusts. In these cases, an incline or tunnel, will necessarily take in a portion of the wall—sometimes on one side, sometimes on the other.

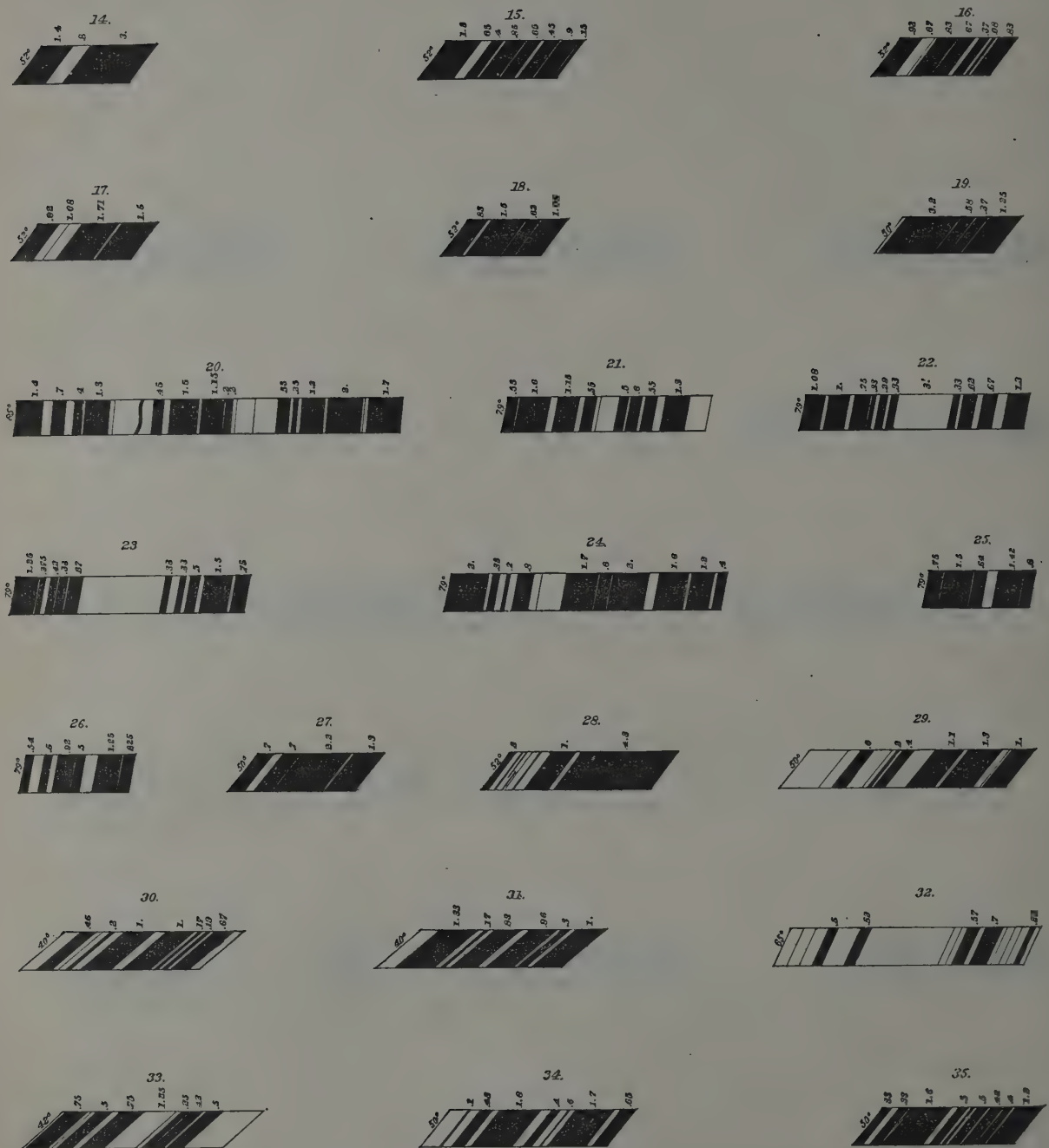
There is another most important peculiarity in the behavior of the principal coal-seams, noticed in the eastern portion of the field. The surface of the ground on which the coal-bed was originally laid down is most irregular. For a length of 2 miles at least, and for an undetermined width, but presumably covering quite an area altogether, the surface was covered with gentle undulations in the form of knolls, of varying and irregular dimensions f oftentimes extensive, oftentimes a few feet only either way, with no definite arrangement of the axes. In the hollows of these, overtopping some and only coming up on the sides of others, the material subsequently to be converted into coal was laid down, and finally came the roof of sandstone, capping the whole. These irregularities have furthermore been increased by disturbances in certain parts which have caused both rock and coal to be slickensided and rendered it extremely friable. To both these causes, but in this eastern part of the field especially to the former, is attributed the variation in width of the coal, while in other portions the variation is due more to the latter cause. The topography of the beds underlying the coal hence causes frequent rolls in the foot-wall, and has a most important bearing on the determination of the field. It naturally acts in depth as well as in horizontal extent along the outcrop, causing an ever-changing variation in the width and amount of coal. In fact, it was most satisfactorily proved that wherever such a condition of variation exists along the surface the same variation will be met with in sinking upon the deposits. It is by no means safe to be attracted by a large showing of coal in any

Plate LXIII.



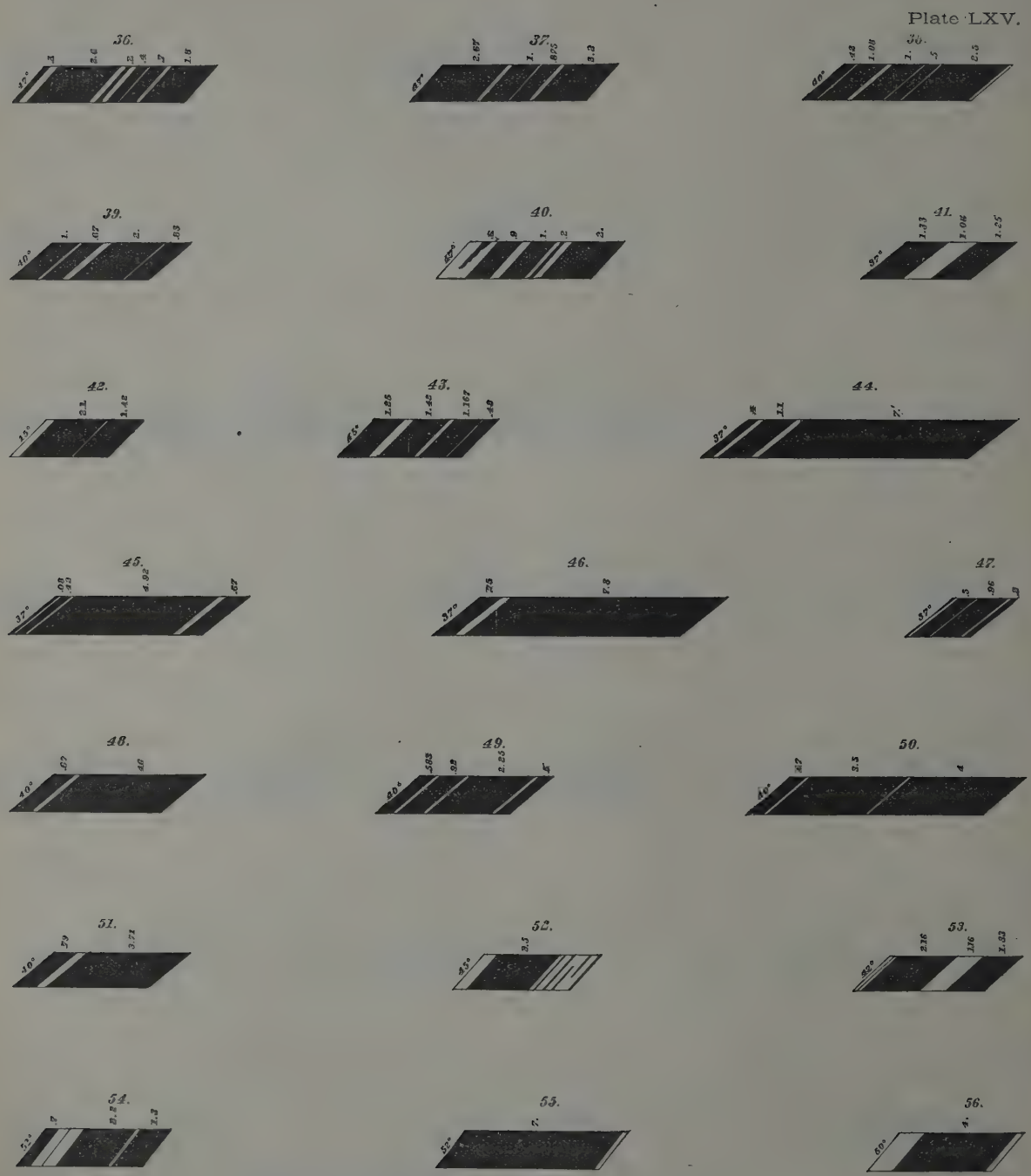
From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF COAL-SEAMS IN THE BOZEMAN COAL-FIELD. By Geo. H. Eldridge.



From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF COAL-SEAMS IN THE BOZEMAN COAL-FIELD—Continued.



From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF COAL-SEAMS IN THE BOZEMAN COAL-FIELD—Continued.

From unpublished MS. material of the Northern Transcontinental Sarvey.

SECTIONS OF COAL-SEAMS IN THE BOZEMAN COAL-FIELD—Continued.

part of this field without a corresponding knowledge of the surroundings. A most excellent example of this is a given in Figs. 49 and 50 of the Bozeman coal-field sections (Plate LXV), each 148 feet down the incline, the section in Fig. 49 being taken 30 feet east of the point at which 50 was taken. Within 40 feet farther east the coal entirely disappeared, there being in its place nothing but a brown lignitic shale, the ends of the shale and coal being dovetailed in together. In passing down the incline which opens this locality, there are several places where within 20 feet of an excellent thickness of coal there exists either none or only a few inches. In the other portions of the field the thickness of the bed is due to the usual causes effecting the deposition of the material, excepting where the coal is pinched out by a small fault or slip in the inclined bed itself. This frequently happens where slight movements have taken place, and is especially noticeable around the ends of anticlinals. The extent of the barren space is never over 20 or 30 feet, and usually under the former figure. The term "pinched out" is here used b merely to convey an idea of the appearance of the bed, and not as it is used in reference to metallic veins. The constitution of the two important seams of coal is well represented in the sections from different parts of the field. So great is their variation in their component parts that it is in places most difficult to determine which is the A and which the B seam, and it is especially so because where the one is developed to a large extent the other is often apparently of little consequence. Throughout their entire length the beds are composed of strata of coal separated from each other by layers of sandstone and arenaceous clay, which are at times perfectly free from all carbonaceous matter, and at others contain a very large percentage of such material, rendering the stratum jet black in color, but with the texture and appearance of sandstone or clay, as the case may be. Between these two conditions we have every gradation, but between the coaly sandstone or clays and the coal itself there seems to be no gradation c whatever. In other words, the Bozeman coal is remarkably free from what is ordinarily called "bone", and it may be noticed here that this is rather an advantage than otherwise, since should it be deemed desirable at any time to wash the coal, the difference in the specific gravity of the coal and sandstone would probably permit ready separation, which operation would be more difficult were the sandstone and clay replaced by bone and the various gradations between coal and a very coaly sandstone.

Of these bands of sandstone the thicker are of the greater persistency, oftentimes extending for a mile or two, while most of the thinner ones, of from one-eighth to one-half inch thickness, are of much less extent. All these bands vary in their thickness, narrowing and widening from point to point, but never entirely disappearing, for a thin paper-like leaf separating two strata of coal always remains. It must not be understood, however, that the stratification has no regularity whatever. Quite the contrary; for oftentimes the strata continue for several hundred feet with the greatest regularity. In illustration of what has been said in this connection, notice the d series of sections Nos. 14 to 19, inclusive, Plate LXIV, of the Bozeman coal-field sections, taken in a tunnel at the north end of the middle anticlinal, where the dip is 52°.

Fig. 14 is a section of the A seam at the mouth of the tunnel; Fig. 15 is 60 feet in from the mouth; Fig. 16 is 195 feet in from the mouth; Fig. 17 is 220 feet in from the mouth; Fig. 18 is 232 feet in from the mouth; Fig. 19 is from a surface-pit a few hundred feet south of the tunnel.

Again refer to the series Nos. 21 to 24, inclusive (on the same plate), representative of the workable seam on the east side of the middle anticlinal, and about one-half a mile south of the tunnel from which the sections above were taken.

Fig. 21 is a section of the seam at the mouth of the tunnel; Fig. 22 is 200 feet in from the mouth; Fig. 23 is e 300 feet in from the mouth; Fig. 24 is from a surface-pit 600 yards farther south.

This serves to illustrate the persistency, variable in width though they be, of the larger bodies of interbedded sandstone and clay, and the changeability of the smaller strata. Notice the increase in width of the central band of sandstone in section 23 over that in section 22. This would undoubtedly, at a distance farther in, have come down to its normal thickness as shown in section 21, as not only does no trace of its greater width appear in section 24, but also in driving the tunnel just such a change was encountered at a point somewhere about 100 feet back of this one. In that case, however, it was of only 25 feet duration altogether. As an illustration of variation in depth, notice sections 25 and 26, 20 and 33 feet, respectively, below the surface of the ground, at a point half a mile south of the last series of sections. The thin stratum of sandstone next the upper bench of coal has become very important, only 13 feet below, and another equally important one has come in in the meantime. Still another f variation is seen in sections 30 and 31, 30 and 71 feet down an incline in the bend of the synclinal between the eastern and middle anticlinals, where the dip is northward. As a final illustration in variation in the composition of coal-beds, notice sections 44 to 51 (Plate LXV), excluding No. 50, which has already been referred to above. Here the variation in width has confined itself to the coal, and is assignable in a great degree to the original topographical features of the underlying beds; whereas, in the other cases sighted, it has been due to the regular causes ordinarily influencing the thickness of deposition of strata, and which in such cases in this field confines itself apparently to the sandstone and clay partings.

Sections 44 to 51 of the B seam are representative of the deposit about 2½ miles east of the central meridian of the field, at the following depths in the incline sunk for prospecting purposes: Section 44 represents the seam at the surface; section 45, at the depth of 53 feet; section 46, at 60 feet; section 47, at 70 feet; section 48, at 80 feet; section 49, at 148 feet; section 51, at 280 feet.

a Between the depth of 80 and 148 feet, I think, the coal entirely disappeared, as already previously described, and on either side of this deposit, at varying distances of from 5 to 40 feet, for the entire depth of the incline, not a sign of coal existed. This state of affairs, alternate rich and barren portions, probably exists for a distance eastward from a point 1½ miles east of the central meridianal line of 2 or 3 miles at least. On the west of this, from the meridian eastward for 1½ miles, we find the strongest persistency in the width of the coal-beds, as shown in sections 36 to 40 (Plate LXV), which also undoubtedly holds for the depth, as section 37 is at a point 40 feet down an incline of which section 36 was the surface-pit. The same uniformity was observed at a depth of over 70 feet in the same pit.

The few places at which both the A and B seams are exposed are represented as follows: The A seam, in the eastern part of our field, is seen in section 52, the B being the one already discussed. The A seam, near the central b meridian, is represented by sections 33 and 34 (Plate LXIV), the B being those already referred to, with one or two possible exceptions undeterminable. In the synclinal contour between the middle and eastern anticlinals, the A seam, of very short duration in its horizontal development, is seen in section 54 (Plate LXV); sections 27 to 29 (Plate LXIV) being of the B seam, each about one-half mile from the other. Around the end of the middle anticlinal, the A seam is represented by the sections 12, 13 (Plate LXIII), and 59 (Plate LXVI), the B by sections 56 to 58 (Plates LXV, LXVI).

Sections 1 to 10 (Plate LXIII) were taken along the outcrop on the eastern side of the western anticlinal, sections 6, 7, and 10 being south of the railroad, the others north. A most remarkable change in the bed is noticed in sections 4 and 5, in all probability of the same seam, at points 300 to 400 feet from each other. The coal of this anticlinal c south of the railroad is rendered less valuable on account of the severe and frequent crumpling it has experienced, while at the north end of the same anticlinal it is of no value whatever, having almost entirely disappeared.

There is a third seam occurring some 300 feet below the two seams already described, which is only now and then of noticeable thickness. It cannot be considered workable as it is variable. Fig. 52 (Plate LXV) would be a fair representation of it where it occurs. The only localities where it has been observed are a quarter of a mile east of the central meridian and on the east side of the western anticlinal. In the synclinal basin between the middle and eastern anticlinals is a thick pocket of coal (section 55, Plate LXV), no trace of which is found 10 feet on either side. The clay overlying it was remarkably abundant in deciduous leaves, which were too tender to bear transportation.

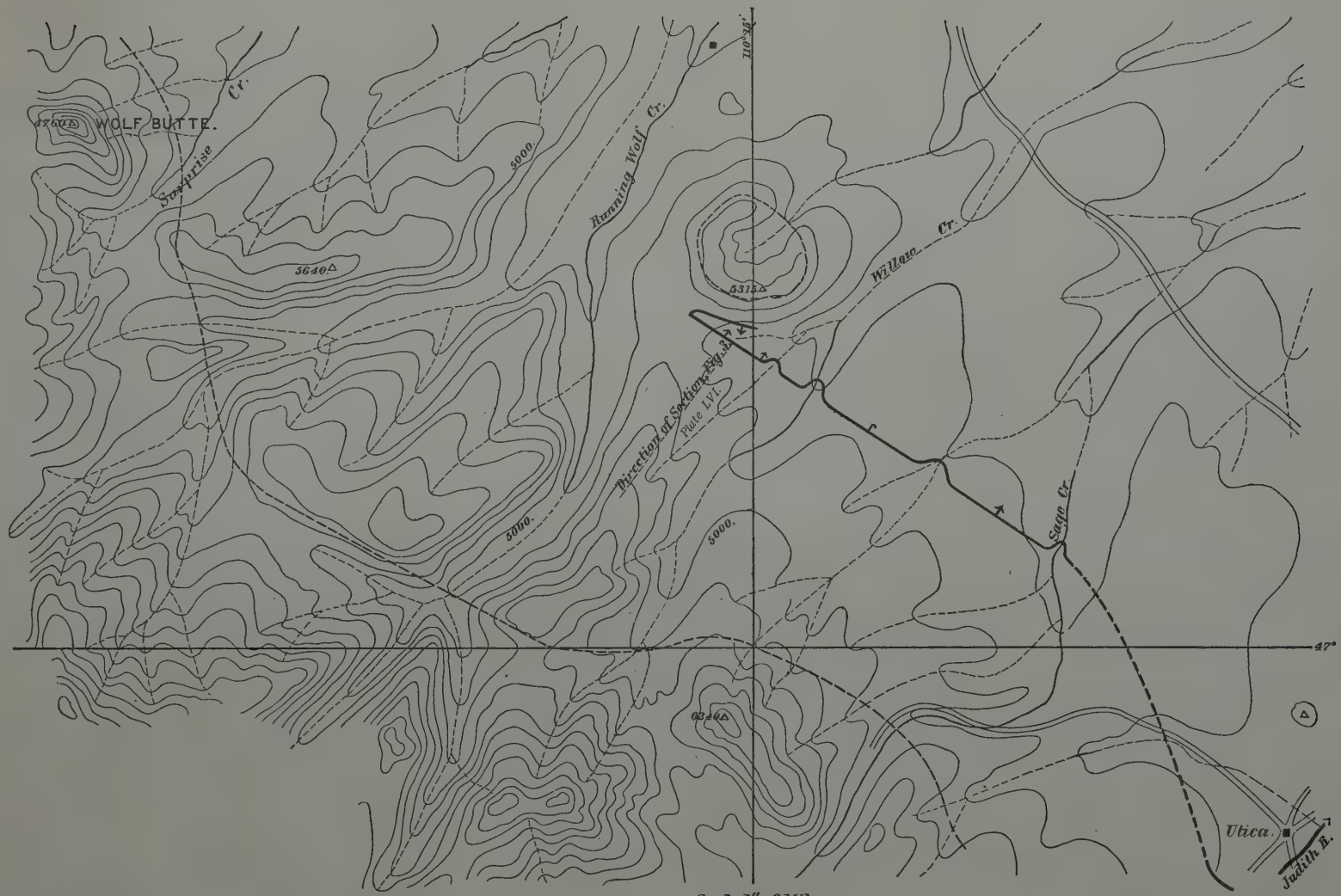
This rather lengthy reference to the various sections in the different parts of the field has been made as the experience gathered from these first explorations on the slopes of the strong upheavals of the Rocky mountains d proper cannot but be of the utmost advantage in the future to those conducting explorations in other similarly-situated fields.

The physical characteristics of the coal in the Bozeman field divide it into two distinct varieties: a solid block or dicey coal coming down, if necessary, in pieces as large as the width of the seam will allow, and withstanding weather and transportation excellently; and a friable chippy variety coming out in lenticular masses, which, upon being allowed to remain on the dump or upon being transported, crumble into minute fragments an inch or so long by half an inch wide, and of a thickness of about one-eighth of an inch. Examination of these small pieces usually reveals a mass of thin, leafy laminæ of coal, one on the other, their edges overlapping. But at times instead of this we find a piece to be composed of infinitesimal pieces of the dicey variety, and when broken these small particles grit over the hand in the same way as does the ordinary dicey variety.

e The friable variety occurs at times where any sharp fold appears, though the dicey coal may also appear in like position, and also in the eastern part of our field from 2½ miles east of the meridian of 110° 45′ eastward to beyond the Yellowstone river. In this latter part of the field there are numerous slight folds, but it seems impossible that since we find the dicey coal, the usual coal, in positions quite as disturbed as this, this chippy texture should be due alone to disturbances in the inclosing strata.

Both varieties are bituminous and make a fair coke, though perhaps the friable coal gives a more uniformly excellent result. To the eye it appears more fatty, oily, and resinous, and of a more brilliant luster than the dicey variety, and soils the fingers much more. It is not at all uncommon to find short, thin, ⅛-inch streaks of resinous matter in it, scattered about over the face, which is not so uniformly the case with the jointed variety. On exposure to the atmosphere its oily luster gradually disappears. The streak is sometimes black, but usually a decided brown, f and after a few days exposure much of the coal has taken on a distinct brownish-black color. Here and there, however, it, as an exception, retains its black color, though it loses its oily luster. This is especially the case toward the western limit of its occurrence, in proximity to the coal of a jointed structure. As we go eastward we find the brightness, and oily luster, and black streak giving place to a dead and dirty brown variety.

The dicey coal, of much the same appearance as the ordinary bituminous coal of the east, is met with everywhere west of the divide, or west of the meridian of 110° 45′. It can be mined in excellent shape for transportation, being very hard and solid, and consequently not only coming out in large blocks, but being capable also of easy separation from the sandstone and clay layers already referred to. The luster of the coal is bright and black, and the fracture perfectly regular. The coal throughout the entire field is very uniform in its physical characters, according to which of the two varieties it belongs. Nowhere are the compounds carrying sulphur to be found in any greater visible quantity than a small nodule of pyrite, or a few spangles of gypsum. There is



Scale 1" = 2 Miles.

From unpublished MS. material of the Northern Transcontinental Survey.

MAP OF THE JUDITH COAL-FIELD, MONTANA. By Geo. H. Eldridge.

NOTE.—The heavy line shows the position of the coal outcrop; the heavy dotted line its approximate position.

therefore in this particular a vast difference between this coal and that of every other field in Montana that has a been explored, for elsewhere the sulphur-bearing constituents occur in conspicuous quantities, both in the direction of the lamination and in thin laminæ in the vertical joints and cleavage planes.

Both varieties of coal are most excellent for all blacksmithing purposes, but the dicey alone is superior for locomotive use. Its combustion is rapid and steam is quickly made. In giving the analyses, it may be said that the samples were most carefully taken with reference to both proving the practical value of the coal, and to bringing out any peculiarities likely to develop in the analyses as judged from its physical appearance. As necessity demanded, it was sampled bench by bench, or by the entire seam, excluding, of course, such portions as would be excluded in mining and shipping. By reference to the sections the exact meaning of each sample and analysis will be gathered. b

The northern coal-field.—This field may be considered as composed of two distinct areas, but of identically the same bed of coal throughout, though it has not been proved continuous, nor is it indeed probable that it is between that portion known as the Judith coal-field in the southwestern part of the Judith basin and that lying to the west, between the Missouri river and the Highwood and Little Belt mountains, and comprising the coals of Belt creek, Sand coulée, and Deep creek. The extent of neither field has been proved, consequently what is given beyond is merely the result of superficial exploration, superficial in both geology and topography. Our examinations have always been regarded in the light of preliminary work toward proving the presence or absence of valuable coals in these localities, and the results here presented will serve only as an excellent basis for further examinations in the future. The sketch (Plate LXVII) of the small area covered by our work in the Judith shows in the c southwestern part the northern slopes of the Little Belt mountains, and northward the edge of the far-reaching prairie-lands extending beyond the Missouri river.

The area southwest of the light dotted line, and also the center of the dome, a geological inlier at the western end of our coal field, are occupied by the pre-Cretaceous rocks, the Cretaceous strata occupying the remainder of the sheet. In this part of Montana the pre-Cretaceous rocks consist of Carboniferous limestones and Jurassic strata, without the development to any great extent of the quartzites met with beneath the Bozeman coal field, the effect of which is to bring the Carboniferous and Jurassic limestones in close succession.

In the Judith basin, at the southwestern edge of the map, there occurs, in addition to the stratified rocks already mentioned, a narrow belt of granite, width undetermined, accompanied by a band of magnetic iron ore, the relations of which to the stratified rocks were, for various good reasons, left undetermined. The ore is steel-gray, strongly magnetic, unless, as in few instances, exposure to atmospheric influences has altered it to limonite. It d outcrops in heavy masses, from one-half ton to 20 tons weight, the outcrop varying in width from 2 feet to what would seem from the float to be at least 15 feet, though perhaps this may be too great a width. The question of width could only be solved by systematic prospecting. The trend of the ore-body is, as nearly as could be determined, about north 70° west. In the vicinity of the head of Wolf creek it was traced by float for 2 miles, but with an intervening space of a mile where it could not be found, owing perhaps to a cover of soil and *débris*. At one point on its course it was traced continuously for 3,000 feet. The guide who was with the party, and in whom every confidence as to truth in this matter can be placed, states that he has traced it for from 3 to 6 miles farther to the westward, or midway between the head of Wolf creek and the Barker mining district, seen on the general maps of the survey. Magnetic iron ore is also reported on good authority in the Barker mining district itself. e

The only other points at which iron ore was observed on the border of the Judith basin were in the Judith mountains, north of the Maiden mining camp, where is found also a limited amount of magnetic iron ore, together with a mass of bog-ore (limonite), resulting from the breaking down of the magnetite, which occurs higher up on the mountain.

The Cretaceous strata underlying the coal in the Judith basin are seen in the accompanying section (Fig. 3, of the geological cross-sections, Plate LVI).

(1) The Jurassic limestones.
(2) A rather coarse basal conglomerate, not over 5 or 6 feet thick.
(3) A thin-bedded yellow sandstone.
(4 and 5) Heavy beds of ferruginous sandstone, weathering a rusty yellow.
(6) A white sandstone, lower portion heavily bedded and forming an outcrop of 20 feet; upper part more shaly. f
(7) Gray and drab limestone, about 10 feet thick.
(8) Gray sandstone.
(9) Thin bed of coarse calcareous sandstone overlaid by red clays forming the top of the knoll; these overlaid at
(10) by a 2-foot bed of limestone.
(11) Sandstone, thin laminated, fine-grained, weathering brown.
(12) A white calcareous sandstone overlaid at
(13) by a heavy bed of yellow sandstone, weathering in huge blocks, and succeeded by a gray limy sandstone.
(14) The coal.

As already stated, the limestone (No. 10) with the thin bed of underlying red clays forms the most characteristic feature of this section, and in a general way this section remains the same, with perhaps local developments of interstratified clays toward the top, both in the Judith and Belt Creek areas.

a This section is referred to the Dakota on the ground of the unmistakable Colorado overlying it, but no fossils were found occurring in it in any part of our area of exploration. Furthermore, it is composed of the strata usually going to make up this group in the west, a basal conglomerate and heavy beds of ferruginous sandstone.

The line of outcrop of coal in the Judith basin is represented by the heavy black line. It lies out on the prairie at least a mile or two from the foot-hills of the Little Belt mountains. The portion of the outcrop traced, represented by the solid line, has a strike of north 56° west, the coal dipping to the northeast about 10°; but from the probability of the coal-opening on the Judith river being on the same seam, the outcrop evidently bends around with the mountains and takes about the direction of the broken line, with a corresponding dip to the east-northeast. At the western end of the line of outcrop, owing to the local upheaval of the small dome in that vicinity, the outcrop bends around b this inlier to the eastward, with a corresponding dip to the southwestward, and the basin therefore receives its limit at the west by this disturbance. The prairies to the northward were not explored, owing to the lateness of the season, the press of still other field-work before the snows came finally, and the fact that it would not be well then to take any definite steps for the further development of a field which promised so brightly in the future. But from the large size of the coal deposit, from its general appearance of permanence, from its topographical position on the prairies away from the more disturbed regions of the mountains, from its continuance farther westward in the region of Belt creek and Sand coulée, there is every reason to expect at this point a coal deposit of at least fair extent. That the coal-bed suffers variation in its thickness, there is no doubt, as is shown by reference to sections 2 and 3 (Plate LXVIII), the former taken at the eastern end of the solid line, on Sage creek, the c latter at the western end of the outcrop, near Wolf creek. This much knowledge, therefore, of the behavior of the bed guides us as to our expectations regarding the unexplored portions. From its slight dip the field can be most easily prospected, and the limits of its available coal well defined by drilling. The bed apparently thins out to the eastward, as is indicated from the outcrop on the Judith, given in Fig. 1, of the section of the northern coal-fields (Plate LXVIII).

The partings in the seam in this locality are much the same in general characters as those in the Bozeman field, but they contain much more argillaceous material. Where in the former field the partings, especially the larger ones, were composed of sandy constituents, producing a genuine sandstone, here the argillaceous materials largely predominate, forming a genuine slate, usually rather thinly laminated. The coal of this field also is bituminous.

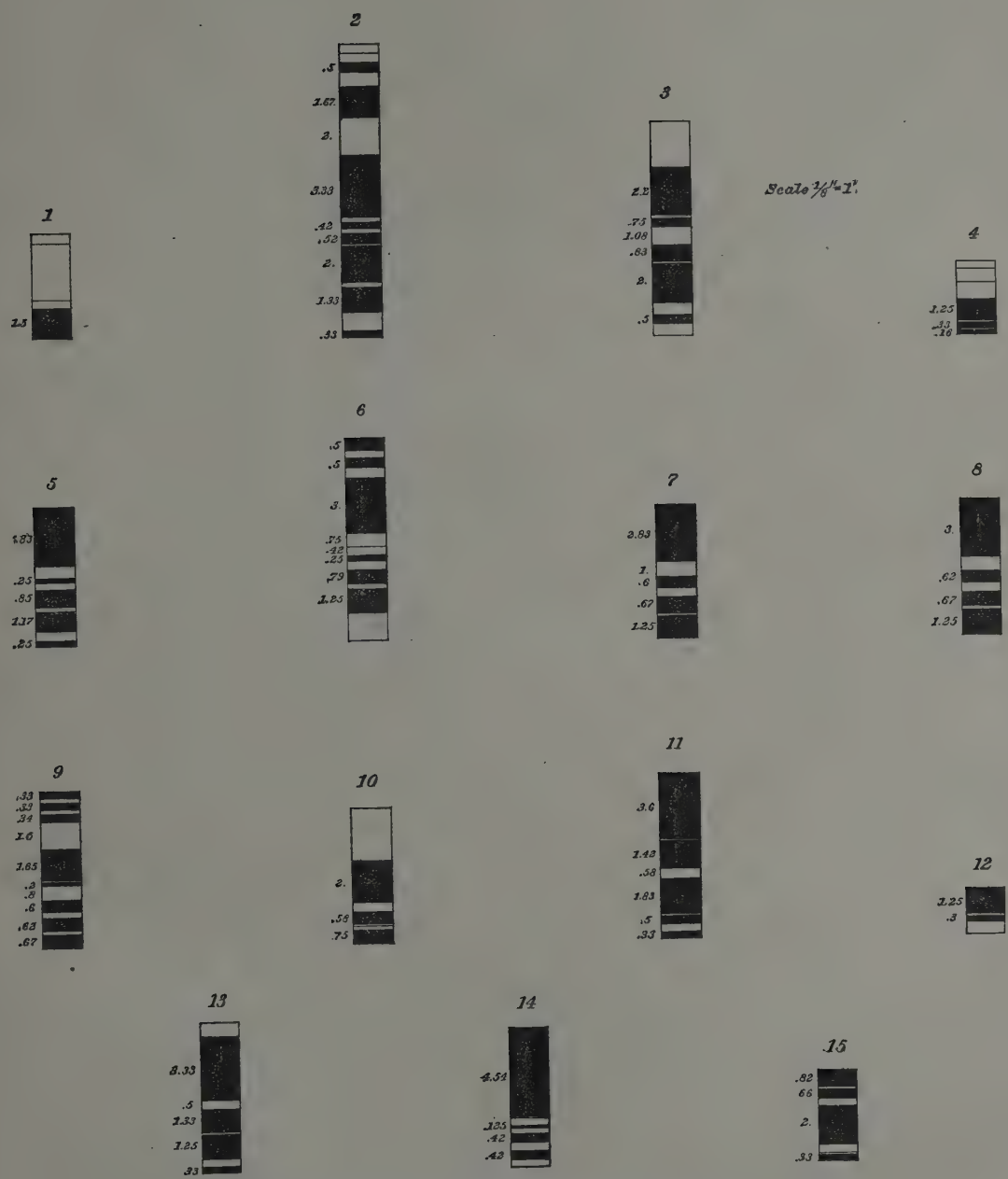
The one variety of *jointed* coal alone appears, the friable, chippy variety, noticed in the Bozeman field, being nowhere found either in this or in the Belt Creek field. The jointed coal of the Judith is of a bright, jet-black luster, d oftentimes oily in appearance, having usually a brown streak, sometimes iridescent in spots or in layers, with a decided tendency to lamination, the laminæ being of variable thickness, but none over 1½ inch, the thinner laminæ having a fibrous structure, the thicker being more compact and homogeneous in texture, and having a very prominent conchoidal fracture, and generally occurring in a certain part of the bench, with coal of the fibrous kind both above and below it in the same bench. There is met with in this area, in the section from Sage creek (Fig. 2, Plate LXVIII), near the bottom of the seam, in the next to the lowest band of coal, opposite the figures 1.33, and constituting the lower 4 inches of it, a peculiar substance resembling a muddy coal, having a leaden or bluish color, cutting like graphite somewhat, *i. e.*, sectile, and decidedly heavier than the other coal of the bed. The analyses show it to contain from 10 to 25 per cent. more of ash than the other coal of this locality, the ash running from 22 to 37 per cent. The sample giving the latter figure (37 per cent.) was an extreme one, while that giving e the former (22 per cent.) was in appearance much nearer the ordinary coal, and only had a slight bluish color on being freshly cut, and, furthermore, was not nearly as sectile as the other specimen. This peculiarity was again met with at the Ellis pit, near Mann's ranch, on Otter creek, of which Fig. 4 (same plate) is a section. The coal at this pit was of no value. The coal of the Judith gave no evidence of coking qualities upon analysis, but this may have been due to the fact that the samples were really surface samples, being nowhere taken at a depth beneath the surface of over 10 feet.

The sampling in this field was conducted on the same plan as that already pursued in the Bozeman field, and, indeed, in all the fields examined.

It may be remarked here in passing that besides the coal-field just described in the southwest corner of the Judith basin there are found wholly unimportant beds of coal in the eastern part, near the Judith and Snowy f mountains, and in the high and much disturbed country connecting the two ranges; also on the eastern flanks of the Judith mountains.

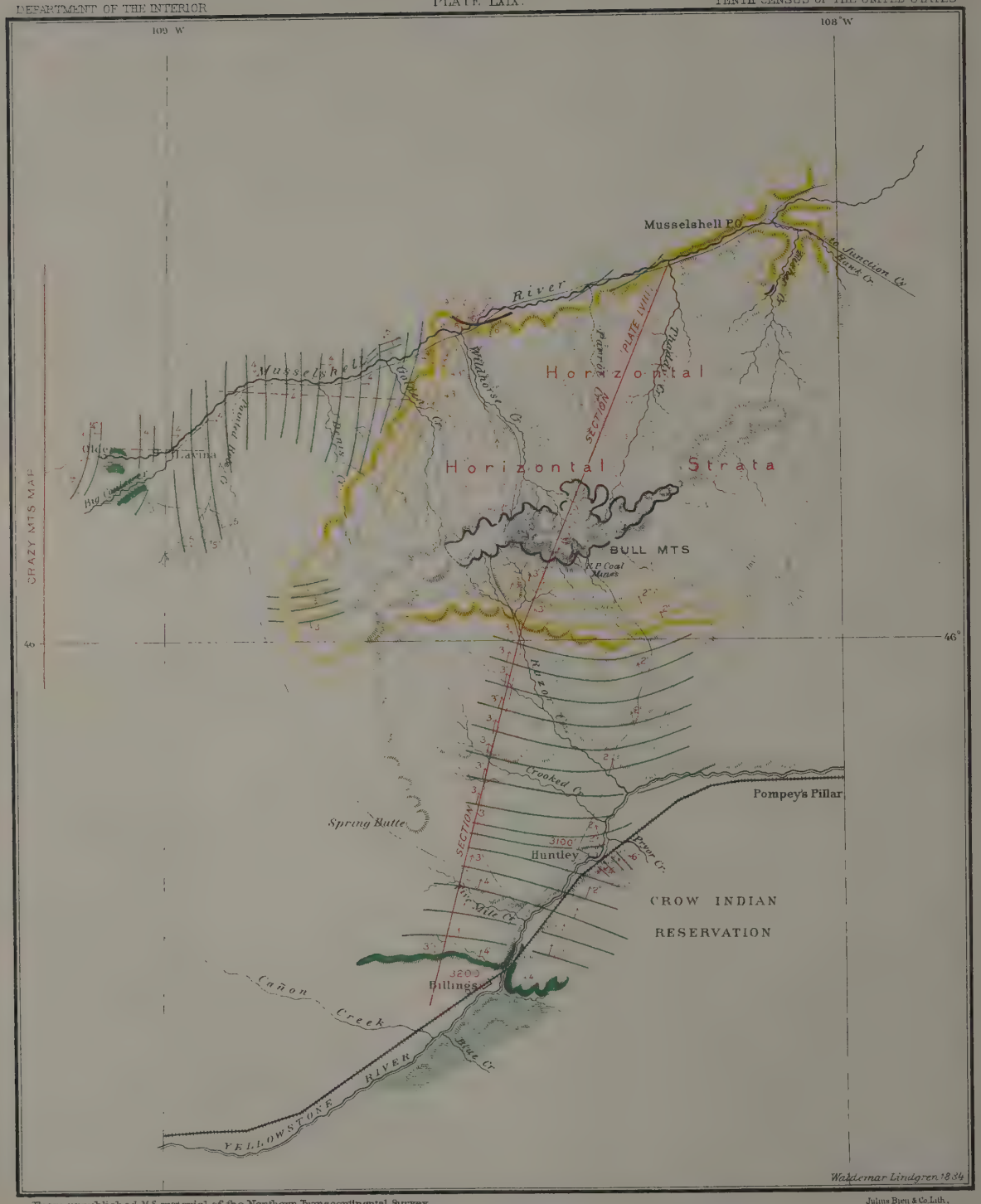
The general geology of the region of Belt creek, Sand couleé, and Deep creek has already been noticed in a casual way. The coal is at the same horizon as that just discussed, underlaid by much the same succession of strata, and overlaid by the strata represented in Fig. 6 of the geological cross-sections (Plate LVI), and given in detail on page 742. As in the Judith field, the coal lies on the prairie, a little farther out perhaps from the region of upheaved strata, and overlaid at a distance still more remote from the mountains by the dark shales of the Colorado group; but there has also been preserved, immediately overlying the coal on Belt creek, a landmark of erosion extending some 1,300 feet up into the Colorado.

The outcrop of coal has a general east and west course, with a northern dip, and skirts the edge of the prairies to the Missouri river, though at a point not determined, between Deep creek and the river, it probably runs nearer



From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF COAL-SEAMS IN THE JUDITH COAL-FIELD. By Geo. H. Eldridge.


109° W
108° W
46°
Musselshell P.O.
Musselshell
River
Junction Cr.
Horizontal
Horizontal Strata
SECTION
PLATE LVIII
Wildhorse Cr.
Golden Cr.
Twenty Cr.
Twenty Cr.
Twenty

the mountains, until finally, south of Ulidia, at the Chestnut ferry, it partakes of their disturbances and loses much a of its economic value. The entire length of its outcrop cannot be far from 25 miles.

The seam is constituted much like that of the Judith. In fact, the remarks made concerning the composition of the bed and the physical characteristics of the coal in one locality are equally applicable to that of the other. The quantity of coal, perhaps, remains persistent over a larger area in this last region than in the Judith, and, perhaps also, there are generally fewer partings. It is certain that the coal lies more compactly in the Belt Creek field than in the Judith, the wide parting of slate in the latter being much reduced in the former, and the relative thickness of the upper and under benches has changed.

The bed has been much more extensively opened in the Belt Creek area, one or two mines here having supplied Fort Benton, on the Missouri, with coal for domestic and blacksmithing purposes for several years. The two lower benches, below the widest parting, in the immediate vicinity of Belt creek, are said to be especially good for b the latter purpose, and also yield a very fine coke. The universal opinion in Fort Benton is that this coal excels the Fort McLeod coal in British America, some of which finds its way into the Benton market by the return freight teams from that northern post.

In noticing the sections of these coals, Figs. 5 to 15 (Plate LXVIII, it should be observed that No. 12 is probably a section of a different seam from the large one here discussed, and overlies it. It is possibly only a local development, and of no value.

The amount of sulphur compounds appearing to the eye in the coals in this northern field is much in excess of that in the Bozeman field, and very much less than that of the Bull Mountain coal. In the Judith basin proper it is especially abundant in the unimportant seams occurring near the eastern edge, notably in the coals on Big Spring creek, where by far the largest amount observed in the coals of Montana was noticed. c

THE BULL MOUNTAIN COAL-FIELD.

Most unfortunately, the exhaustive explorations being conducted in the Bull mountains were brought to an untimely end by circumstances over which our survey had no control. Two months more in the field would have sufficed to complete the data for a valuable report on a valuable field of coal. As it is, however, the most northwestern extension of the field was left unsurveyed, though carefully examined, and the topographical and geological map of the entire field has been left uncompleted, owing to the disbandment of the survey. For reference and aid a small general map (Plate LXIX) has been constructed, which will, of necessity, have to answer our purposes. The geology of the Bull mountains has already been fully given under the description of the Upper Laramie in d Mr. Lindgren's notes. These additional notes on the topography of the mountains and adjoining country by the same gentleman may also be here inserted:

The district examined is situated in central Montana, between the parallels of 45° 30′ and 46° 30′ north, and the meridians of 108° and 109° west.

The Musselshell and Yellowstone rivers here for some distance flow nearly parallel, at a distance of about 40 miles. The valley of the Yellowstone is bordered by bluffs from 100 to 200 feet high. For miles northward the country stretches, a gently rising, hilly, dry plateau, only to be used for grazing purposes. The creeks carry running water in the spring only. About 24 miles north of Billings on the Yellowstone, the appearance of the country changes. It rises more rapidly, is cut up in high bluffs, deep gulches, or dry creeks; the ground is covered with thick grass and a quite abundant vegetation of pines; still it is very dry; the water-supply during the summer and fall is limited to a few springs. e

This part of the country coincides very closely with the geological extension of the highest series in the Laramie, the Bull Mountain series. The center of this district, situated about 30 miles north of Billings, and 15 miles south of the Musselshell river, is occupied by a deeply eroded and cut mesa, the Bull mountains rising to 5,000 feet above the sea, or about 2,000 feet above the Yellowstone river at Billings. Westward, the divide between the Yellowstone and Musselshell has a southwesterly trend, and is yet for a distance of 30 miles from the Bull mountains covered with pine vegetation; from there, however, it lowers, and the bleak and barren plateau stretches between the two rivers. Eastward a narrow plateau, about 4,000 feet above the sea, extends for 10 miles; from there the country lowers considerably, but is still for a long distance occupied by the Bull Mountain series. The Bull mountains proper, that is, the highest 800 feet of the series, extend only about 10 miles east and west, and 5 or 6 miles north and south, and form, as already mentioned, a very much eroded and cut up mesa, separated on the outskirts into several square or pointed buttes.

They are the last remnant of the enormous sheet of Laramie formation once covering the country. The erosion is going on rapidly. Deep, narrow gulches, square buttes, and horizontal, far-extending benches of heavy sandstone give a peculiar aspect to the country. These heavy beds of sandstone are not so easily attacked by erosion as the softer layers, and remain near the central mesa as horizontal benches, forming veritable natural contour-lines. Sometimes a local burning out of a lignite seam has hardened the overlying soft sandstones and imparted to them a deep red or yellow color. f

There exist in the Bull mountains many lignite seams, but the smaller ones having a development sufficient to be of economic value only here and there over the area, and the limits of their workable portions not having been determined, it is best to pass them over without further notice, and proceed at once to the examination of the only seam of large size existing in the region—the "Mammoth seam", as it has been called by way of designation. Furthermore, in view of the great thickness and uniform persistency of the Mammoth seam, the smaller beds of lignite, even where locally developed to a workable size, will not be touched for many years to come. The outcrop of the "Mammoth" bed has been traced every few feet for the entire circumference of the mountains, and but very few of its irregularities are now unknown to our party. On the general map it is marked by the heavy black line

a in the center, which is approximately the shape of the field, excepting that on Wildhorse creek it extends farther down (northward) than indicated, by some 3 or 4 miles, underlying the upper part of the divide between Wildhorse and Parrot creeks.

The coal lies nearly horizontally, but still, by close examination and comparison of the strata over wide areas, it is proved to occupy an exceedingly shallow synclinal basin, the shape of which is not positively determined, but it seems to have its center somewhere near the center of the mountains themselves, the strata dipping inward from the periphery, but never over 2° 30′. In other words, the Bull mountains constitute a geological outlier.

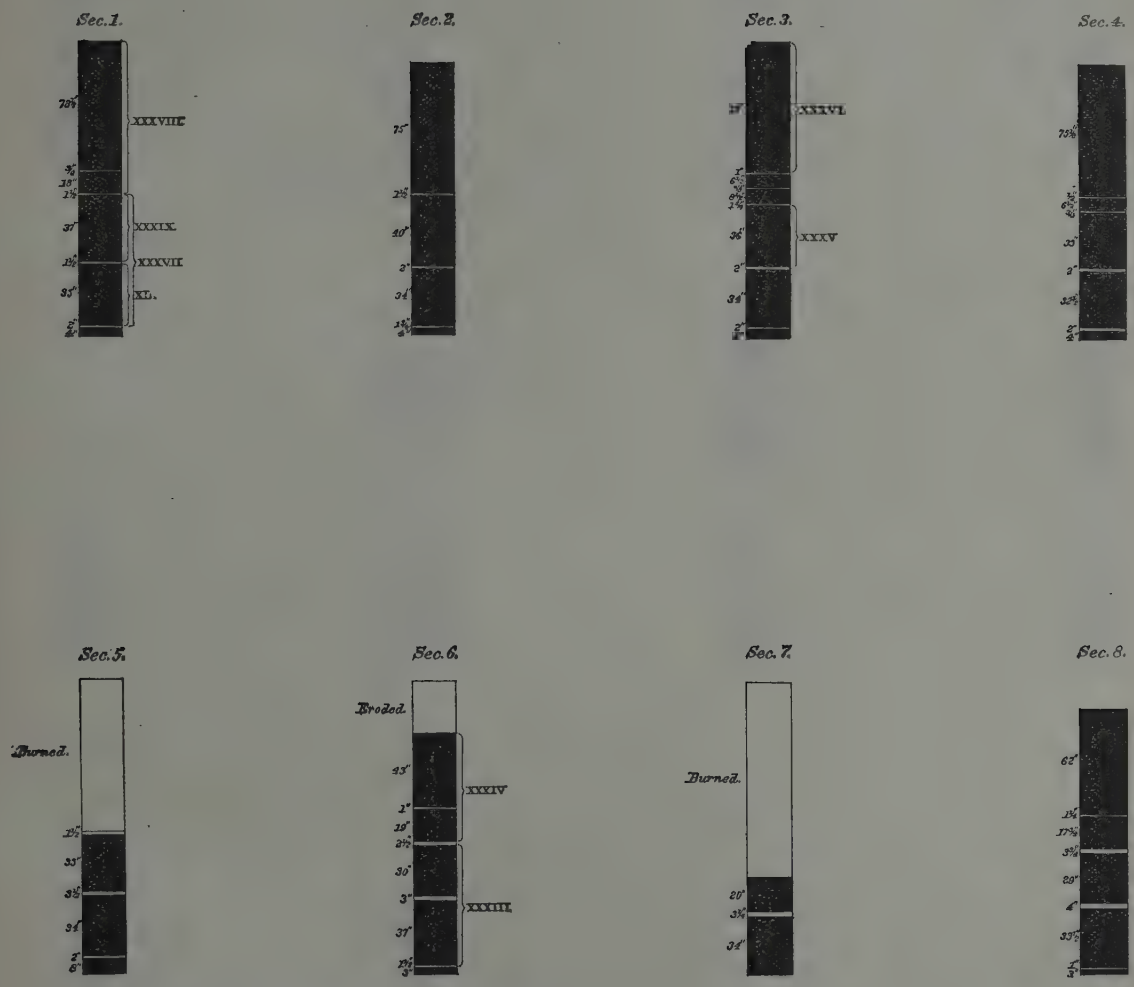
The composition of the bed will be best understood from the sections, following them in their order around the mountain. Taking as our initial point that designated on the general map as the locality of the mines of the **b** Northern Pacific Coal Company, we have, first, Figs. 1 to 4, inclusive (Plate LXX), covering a distance of a little over a mile along the southern front of the mountain. Following the bed to the eastward a mile and a half farther, Figs. 5 to 8 (Plate LXX), inclusive, the same general composition prevails. From our initial point *westward* for from 3 to 4 miles, Figs. 47 to 54 (Plate LXXIV), inclusive, but little difference in the number of benches and the width of the partings exists, though, indeed, the thickness of each bench of coal, especially those above the third bench from the floor (including the little 6-inch bottom bench), varies somewhat, the variation in the large upper bench making a difference in different localities of several thousand tons per acre. Thus, for a distance of from 6 to 7 miles along the central portion of the southern face of the mountains, we find a great regularity occurring in the composition of the bed. Returning to our easternmost point mentioned thus far, some 2½ miles east of the **c** location of the Northern Pacific Coal Company, at the section represented by Fig. 9 (Plate LXXI), we find the beginning of a marked change in the character of the bed. The central parting, heretofore from 2 to 6 inches wide, is on the point of a constant and rapid increase, until at the easternmost point of the coal deposit, and also of the mountains, Fig. 21 (Plate LXXII), it has attained the thickness of 50 feet, separating the bed, as shown, into two workable seams, averaging roughly 6 feet each.

Along the northern side of the mountains, passing westward from this point, this central parting decreases, until at a point directly across the mountains from the point of the commencement of its increase on the southern side, on one of the eastern branches at the head of Thaddy creek, it has again attained its normal conditions, the two sections of the bed being here separated by only from 2 to 4 inches of slate. For a mile and a half to the westward along the face of the mountains it now continues without any important change, when, in passing **d** northward and westward around the northern portion of the central part of the range, Figs. 27 to 32, inclusive, (Plate LXXII), this latter section being on the head of Parrot creek, and at least 3 miles in a direct line from the former, the same parting has again attained a thickness of at least 20 feet to again decrease, Fig. 36 (Plate LXXIII), several miles down the divide between Parrot and Wildhorse creeks, but still on the slopes of Parrot creek. For the remainder of the distance on this side, Figs. 36 to 39 (Plate LXXIII), inclusive, we have again the usual characteristic outcrop, excepting that the little 6-inch bench at the bottom has again disappeared, as is often the case on the north side of the mountains. On the opposite side of this divide, Fig. 40 (Plate LXXIII), *et. seq.*, in the gulches of Wildhorse, we find the seam considerably decreased in thickness, which condition seems to prevail in the low western spur putting out from the main body of the mountains, *i. e.*, on the head of the western branches of Razor and Wildhorse creeks. This decrease seems to be attributable to the absence or diminution in size of the **e** upper members of the Mammoth bed. This brings us around to the sections already noted, 47 to 50, and completes the contour of the coal.

Generalizing the preceding: The Bull Mountain plateau near its summit may be divided into a northern and a southern portion, the latter much the larger. The southern part lies on the divide between the Yellowstone and Musselshell rivers, and extends east and west several miles. The northern or smaller part lies between the heads of Thaddy and Wildhorse creeks, with a long spur running to the northward between Parrot and Wildhorse creeks. Under the high plateau in the center of the southern part, an area of perhaps 20 square miles, the bed attains its greatest thickness, and is most compact, the partings being of a minimum thickness; here the entire thickness can be worked at once. East of this, comprising an area of perhaps 12 square miles, the seam is split into two members, an upper and a lower, each of which must be worked separately. Westward from the central high plateau of the southern portion, for at least 3½ or 4 miles, and comprising an area of at least 12 square miles, the bed is undivided, **f** but has by no means its normal thickness as under the main mass of the mountains. Under the high plateau constituting the northern part of the Bull mountains, for at least one-half of its entire area of 12 square miles, the bed would have to be worked in two portions, by reason of the increase in thickness of its middle parting. The northern spur of this plateau, between Wildhorse and Parrot creeks, may in part be worked from one opening, and in part must be worked from two; these portions are about equally divided, and comprise about 10 square miles. It is estimated that this field contains at least 400,000,000 tons of available coal. In connection with this estimate, and what has been said of the areas, it must be observed that the figures are only roughly calculated, and that should time ever permit the plotting of the map of this coal-field they will be revised and corrected, since the data exist for a very close estimate; but the tonnage given is rather an under- than an over-estimate.

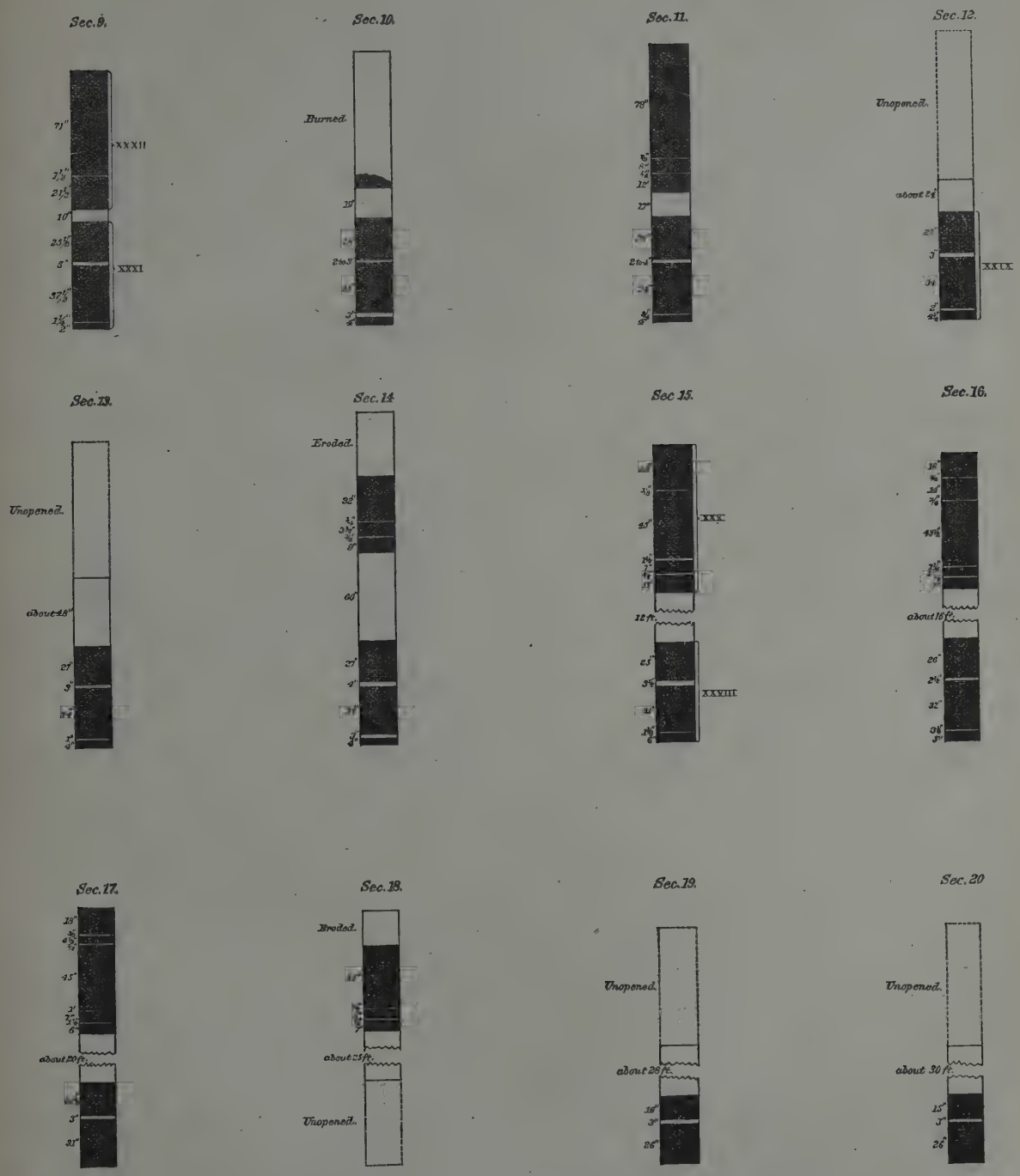
The physical characteristics of the Bull Mountain coals are the same for all the workable seams, that is the "Mammoth" and such parts of the two or three others as are of available thickness. The coal much resembles in

Plate LXX.



From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF THE MAMMOTH COAL-SEAM, BULL MOUNTAIN. By Geo. H. Eldridge.

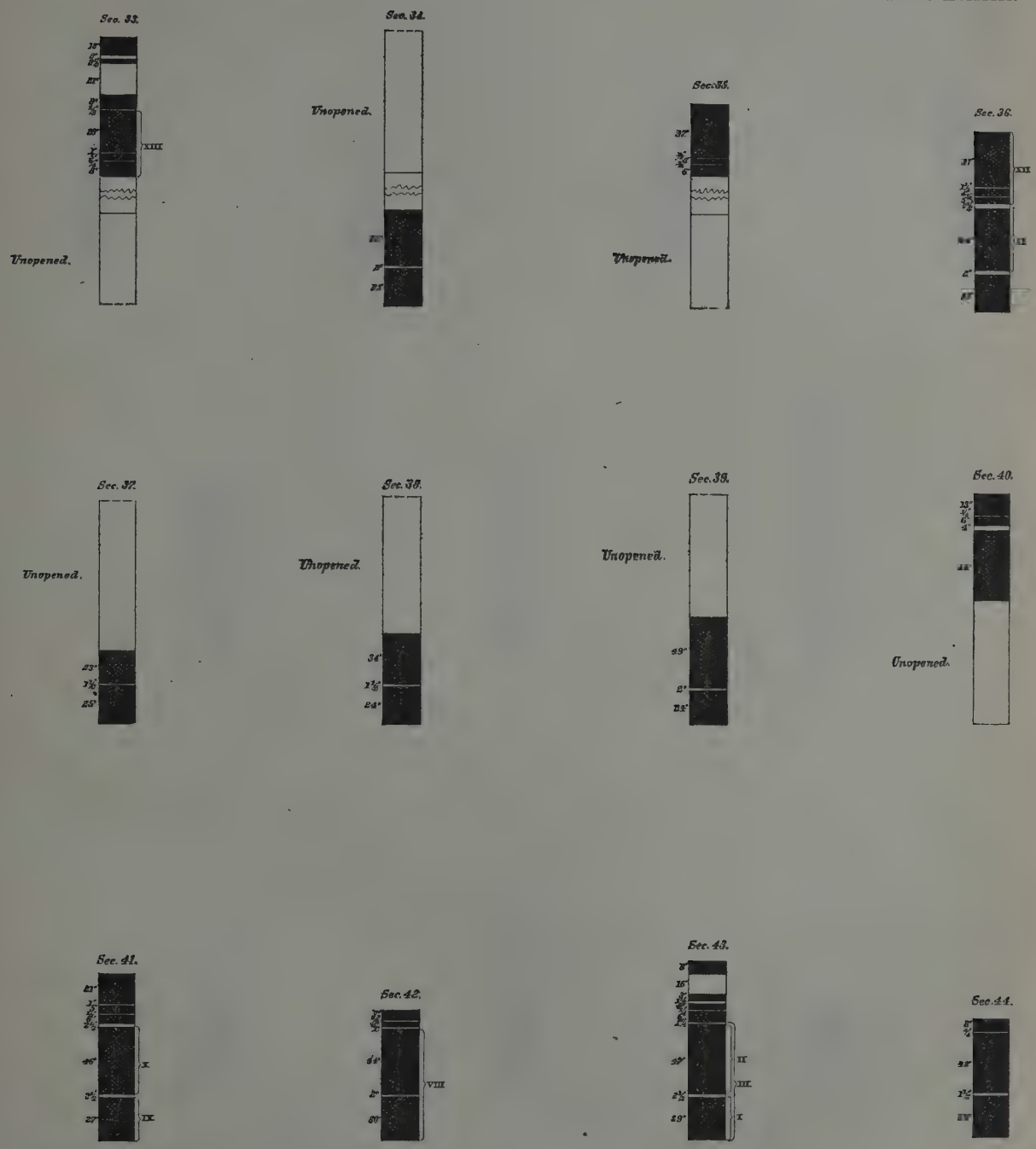


From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF THE MAMMOTH COAL-SEAM, BULL MOUNTAIN—Continued.

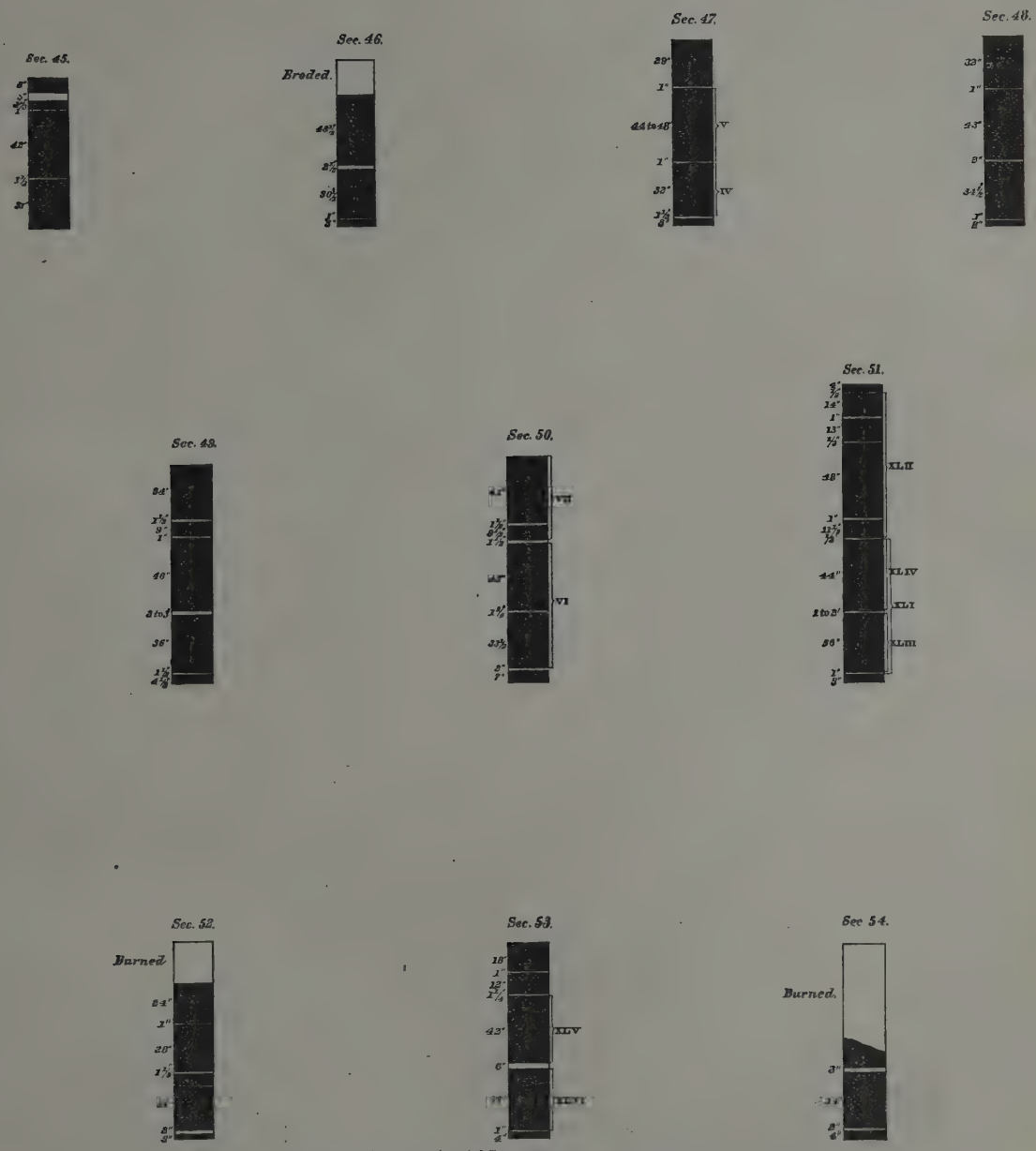
From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF THE MAMMOTH COAL-SEAM, BULL MOUNTAIN—Continued.



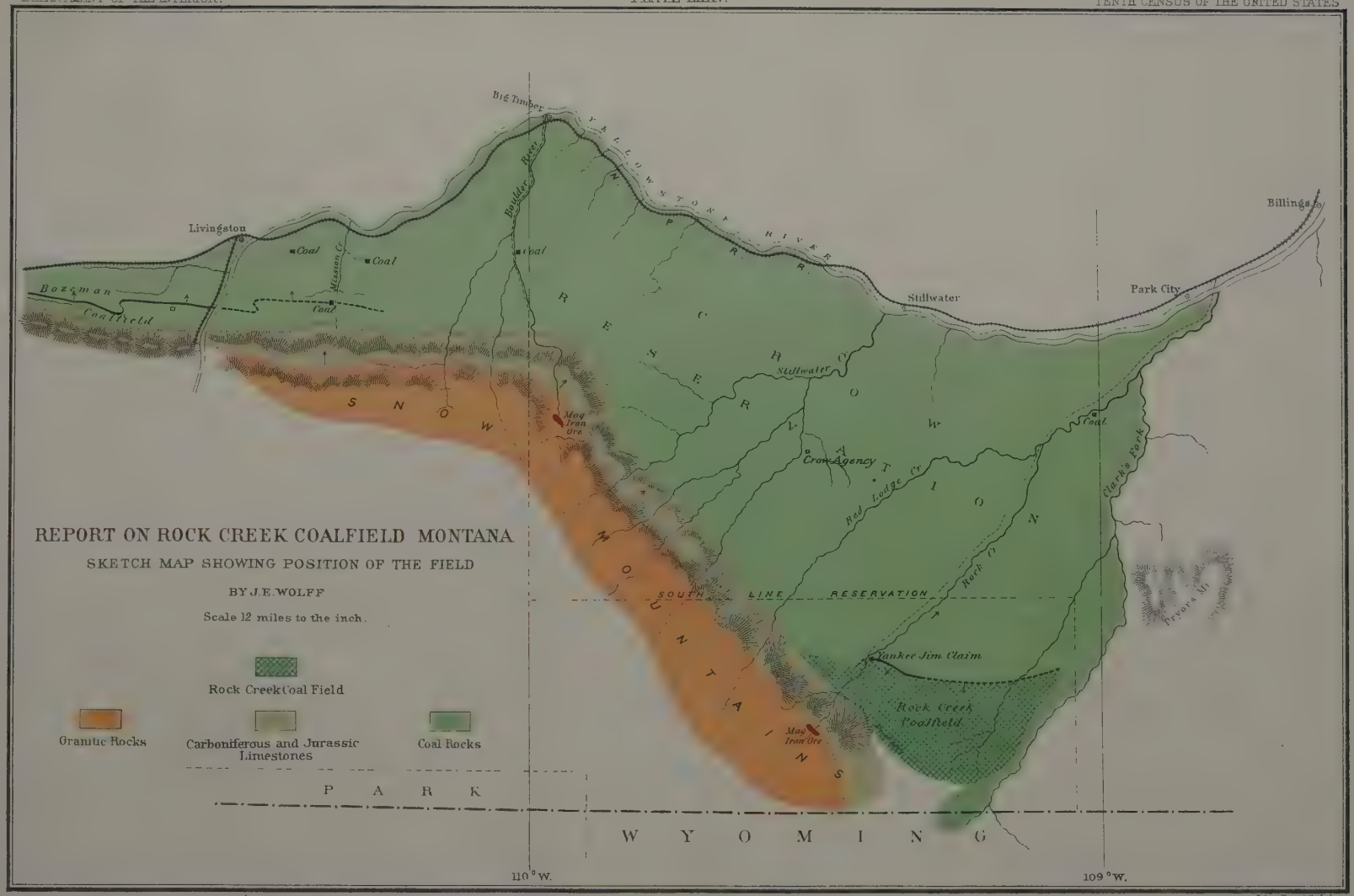
From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF THE MAMMOTH COAL-SEAM, BULL MOUNTAIN—Continued.



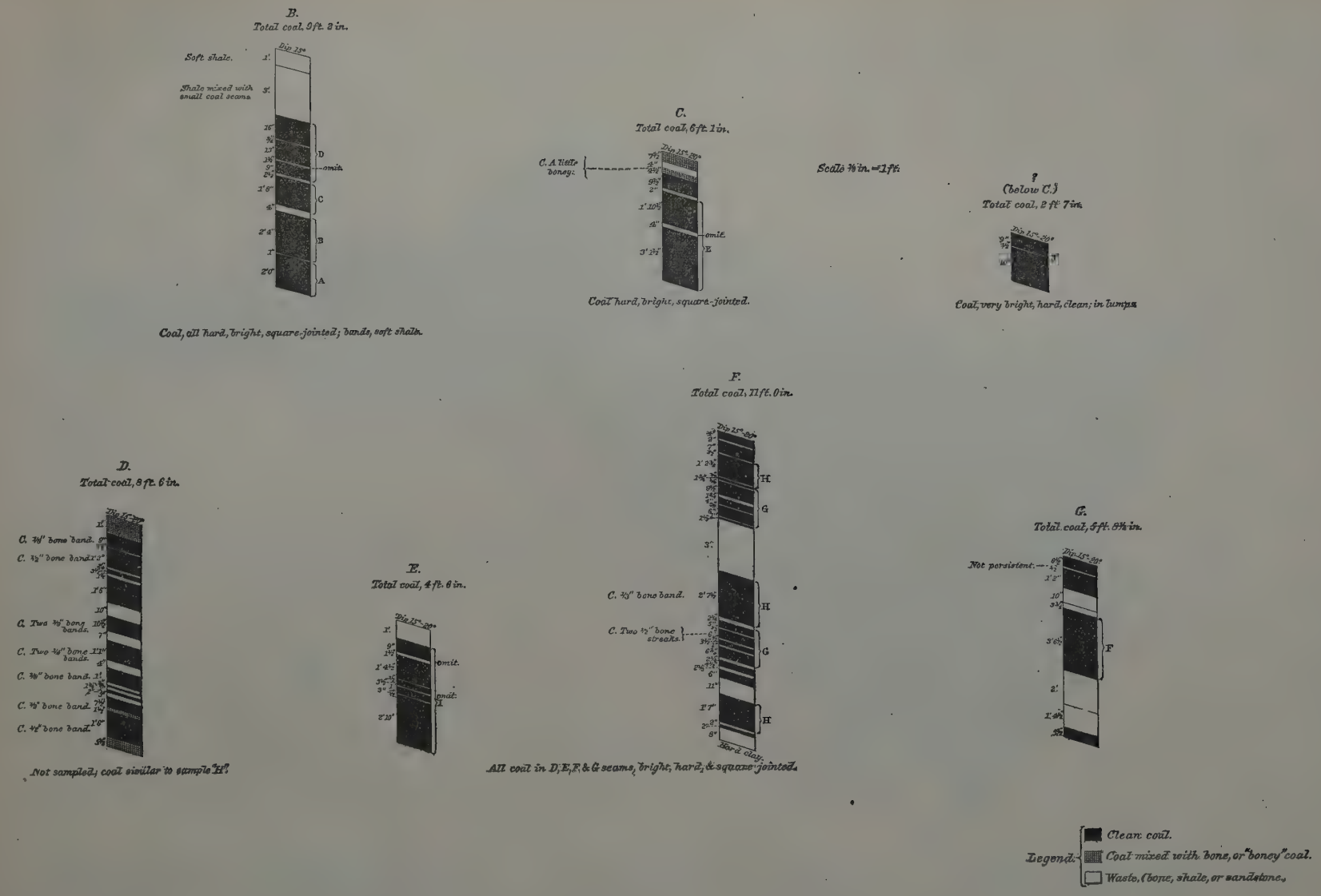
From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF THE MAMMOTH COAL-SEAM, BULL MOUNTAIN—Continued.



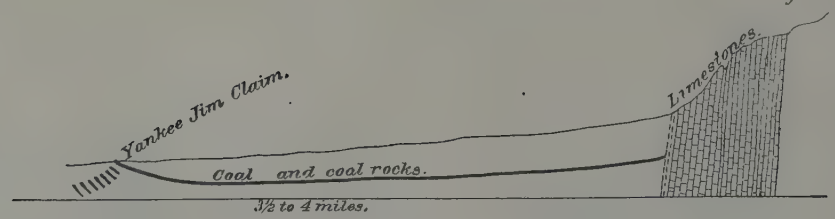
From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.



From unpublished MS. material of the Northern Transcontinental Survey.

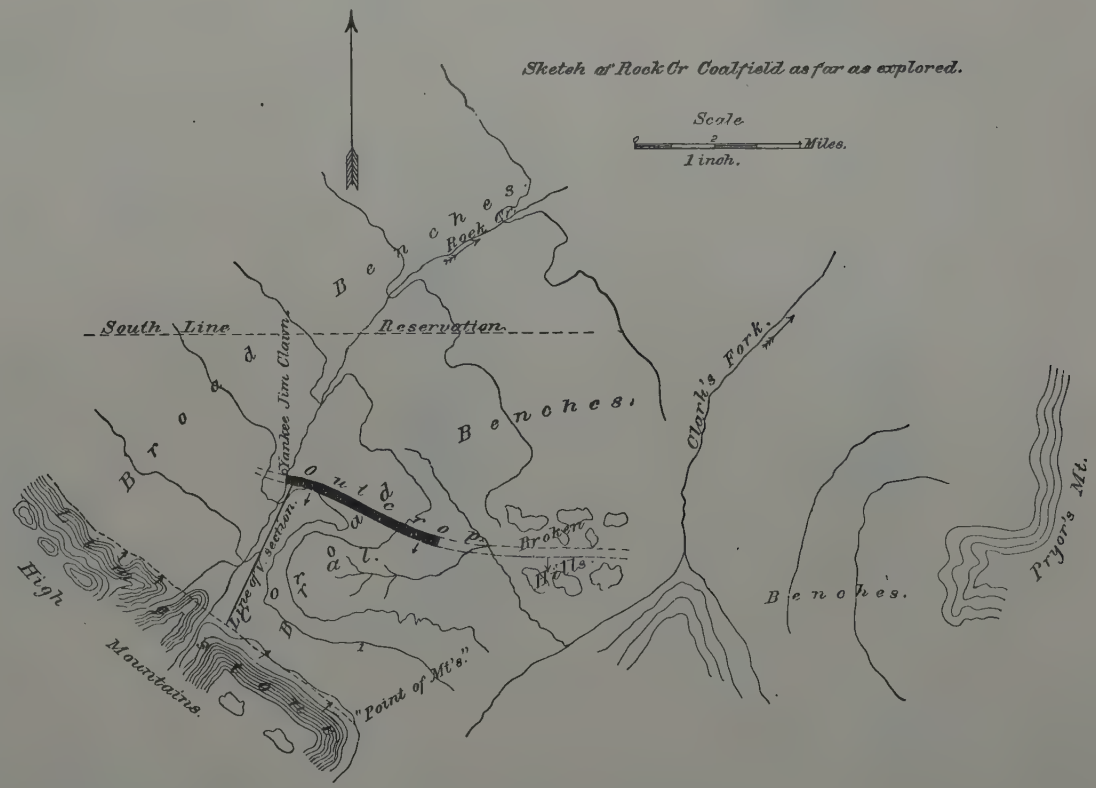
SECTIONS AT THE YANKEE JIM CLAIM, ROCK CREEK COAL-FIELD, MONTANA. By J. E. Wolff.



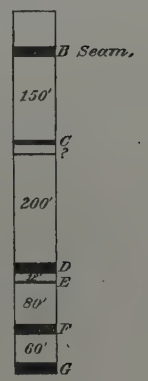
Vertical section across Rock Cr. Coalfield from Outcrop of Coal to Limestones.

Section Coal found on Rock Cr. 16 miles from Park City.

Sketch of Rock Cr Coalfield as far as explored.



Relative position of seams.



From unpublished MS. material of the Northern Transcontinental Survey.

SKETCHES OF THE ROCK CREEK COAL-FIELD, MONTANA. By J. E. Wolff.

structure that of the Judith basin, but is, however, a decided lignite. It has a jet-black luster, at times dry, **a** especially in the fibrous and more thinly laminated variety, at times oily, as in the more heavily laminated kinds which break with an irregular and distinct conchoidal fracture. Its streak is brown, its structure jointed. In mining it comes down in large blocks, which, on exposure to the atmosphere for three or four weeks, are easily reduced to small fragments by handling. It has, however, sufficient resistance to weathering to permit of its transportation over roads to remote points, and is in every way much superior to the lignites farther east. It is brittle and contains compounds carrying sulphur in large quantities, disseminated through the coal in lenticular masses and balls of pyrite, and in the vertical joints and between the laminæ, in thin laminæ of pyrite and spangles of gypsum. On weathering, the coal is very rusty from the oxidation of the pyrite, and white from the deposits of gypsum, which occur both in the crystalline form and also in a fine powder. On being burned, the sulphur-fumes are very strong and readily perceived. The vertical laminæ of pyrite occupying the joints of the **b** coal are often very beautifully arranged, showing a network of layers crossing each other at sharp angles. They are generally very thin and often cut coal and slate alike, passing even into the bench of coal lying beneath the parting. Besides the pyrite and gypsum met with, thin laminæ of "mother-of-coal" are everywhere to be seen.

In passing over the field there is frequently brought to one's notice the numerous places in which the bed has been on fire, and in which it is at present on fire. When burning it is usually detected by the odor of smoke and sulphurous-fumes pervading the air in the vicinity, and, upon examination, it shows the gradual breaking down and falling in of the roof, the brilliant red, yellow, orange, and brown stains from the oxidation of its pyrite striping the face, where exposed to view, most beautifully. Adjoining these brilliant colors, or occurring where they do not, we find an abundance of sooty matter, of a dirty-brown color, resulting from the burning of the coal itself, and often containing particles of coal which have not been completely burned; and it is worthy of note in passing that, at **c** places, all that is left of 10 or 12 feet of compact benches of coal is from 6 to 8 inches of soot. As the support for the roof is thus gradually removed the sandstone and other overlying matter settles down in massive blocks, oftentimes large depressions occurring, which are quite *sui generis* and easily recognized from valleys of erosion. Nowhere have the fires extended over areas greater than a few thousand square feet, and usually they have not reached that extent. In some cases the fires are the result of spontaneous combustion, in others they undoubtedly caught from burning grass or stumps, which latter cause has been observed on the Musselshell during the present season.

The partings of the coal are usually slate, but the prominent middle parting, on increasing to its great width in the eastern and northern parts of the field, becomes a heavy-bedded, coarse-grained, white sandstone, weathering in rounded forms. **d**

The sampling of the coal was done in part by the writer, but chiefly by the assistant of the party, Mr. J. R. Williston, and was carried out in the same careful manner as was that in the other coal-fields in Montana. The samples are representative of the coal from the periphery of the entire field, and were taken in every case from a solid portion of the seam, at a distance from the surface beyond all influences of weathering, pits having been dug for the purpose.

The Rock Creek coal-field.—This field was explored and largely discovered by Mr. J. E. Wolff, assistant geologist of this division of the survey, and such parts of his report as are of general scientific value are here given:

The field lies at the base of the Snow mountains, the high range that extends 100 miles southeasterly from the Yellowstone cañon, near Livingston, and is about 30 or 35 miles due south from Stillwater, the nearest station on the Northern Pacific railroad. Its elevation above sea-level is about 5,700 feet, and above the Yellowstone river at Stillwater about 2,300 feet.

At what is known as the "Yankee Jim claim", on what we have designated as the B seam, the coal crops out in a bluff that rises **e** about 100 feet above the creek-level. This seam was found partially opened at about 80 feet above the creek, but the other seams we ourselves discovered and opened in the bluff lower down. All are easy of access for working. There were found in all seven seams containing workable coal, in addition to several other smaller ones containing a foot or so of coal. In the sketches, Plates LXXVI and LXXVII, will be found sections of these seams. All of the coal is hard, bright, square-jointed, in appearance similar to the best coal of the Bozeman field, while none is of the soft, "chippy" variety there observed. The total thickness of coal in these seams is 46 feet 6½ inches, of which about 46 feet may be said to be ultimately available for mining, if it were desirable to work the coal in every seam. The largest single bench of clean coal (seam G) is 3 feet 6½ inches thick, but, as will be seen from seam B, a much larger amount of coal (9 feet 2 inches) can be mined from one opening with perfect ease and economy. The dip is low, from 15° to 20°, and within a few hundred yards from the outcrop toward the mountains becomes flat. Anywhere between this point and the mountains the coal would be found within a distance of perhaps 300 feet from the surface. The seven seams are contained in about 500 feet of measures.

All samples were taken under cover, but yet not far enough in to obtain the coal at its best, especially for coking tests. Sample J, in physical qualities, was the best coal I have seen in Montana. The D seam was not sampled, but the coal seemed similar to that in the **f** F seam (sample H). Sample G was taken to test the value of the mixture of coal and bone represented in the F seam by that sample, which could not be separated in mining.

Circumstances allowed but a limited time for exploration of the area of this field. From the "Yankee Jim" claim the coal was traced 4 miles, nearly to the Clark's Fork bottom (Plate LXXV), and could be seen by the "lay" of the rocks to extend an unknown distance farther. Coal-croppings are found in these 4 miles, in a band nearly one-quarter of a mile wide, showing that a large number of seams extend this direction. Some natural exposures of the seams are found in the gulches, in one place about 3 feet of coal showing in one solid bench. These facts indicate, therefore, that the coal maintains its thickness and quality from Rock creek toward Clark's fork. Near the outcrop the coal dips toward the mountains, but it gradually loses its dip until at a distance of some hundreds of yards from the exposures it becomes flat, and so continues to the southwest border of the field, where it is terminated by a fault, bringing up the limestones (see sketch-map and vertical section, Plates LXXVI and LXXVII). By estimate the distance from the coal outcrop to the limestones varies from 3 to 4 miles, and therefore the approximate area of the coal-field, *so far as explored*, would be 12 square miles. If the whole area of coal,

a lying flat, was worked, this would give, with 46 feet of coal, about 388,000,000 tons; or, saying that on an average half that thickness of coal were found, 194,000,000 tons of coal. This rough estimate gives some idea of the value of this field should it prove up as the prospects indicate.

A few words may be said as to the probable extent of this field and its connection with other coal-fields. It is the direct continuation of the Bozeman field, distant about 100 miles. The continuation of the Bozeman coal was found as far as Missouri creek, southeast from Livingston (see Plate LXXV). It is reported to crop again on the banks of Boulder creek, and from there runs down to Rock creek, following along the edge of the limestones. In short, the region from the base of the Snow mountains to the Yellowstone river, all the way along the range, is underlaid by coal at a moderate depth from the surface, the measures lying flat except where upheaved locally, and in general along the immediate base of the mountains. Constant discoveries of coal, therefore, are likely to be made along this range in the future. From the "Yankee Jim" claim, the coal, therefore, extends northwest toward the Bozeman field. Coal, rather "bony", was also found lower down on Rock creek, about 16 miles from the railroad. A section is given in Plate LXXVII. This is probably the same coal as that b found at the "Yankee Jim" claim, in which case the other seams could be reached here only by boring. The good quality of the Rock Creek coal, its freedom from dirt, the number of seams, thickness of coal, thickness of single benches of clean coal, and flat position favorable to easy working, will probably place this field among the best, if not itself the best, yet discovered in Montana.

The last field of importance in Montana lies on the Upper Yellowstone, near the Yellowstone National Park, and was also examined by Mr. Wolff, with the following results, taken from his notes:

The Gardiner River coal-field (Plate LXXVIII).—This field is situated on the Upper Yellowstone, about 60 miles above Livingston and the Bozeman coal-field, and extends from the mouth of Gardiner river down the Yellowstone on both sides to within 2 miles of Cinnabar mountain. The river here flows in a general northwesterly direction, Bear Gulch creek flowing into it from the north and Gardiner river from the southeast, together with smaller creeks shown on the accompanying sketch-map.

The north line of the Yellowstone National Park runs from the top of Electric peak east through the mouth of Gardiner river, and c the Coal Measures are found in the area bounded by Electric peak, Cinnabar mountain, Mount Evarts (in the Park), and the base of the mountains rising from the river on the northeast side, opposite Electric peak.

The coal, as traced by Mr. Eldridge a year ago, runs from Electric peak in a high spur of this mountain to Cinnabar mountain, but was not found to be of any value in that distance, the seams being small, none having over 1 foot 10 inches of available coal. The coal varies from a dip of 30° near Electric peak to almost vertical near Cinnabar mountain. South of the latter mountain it is opened in two or three places in the hills at the foot of the higher peaks and spurs. All the coal found in these low hills west of the river, between Reese's creek, Cinnabar mountain, and the spur of Electric peak is worthless for any extensive mining, for the formation is badly broken up by one extensive fault and several smaller ones, and dips in many ways, rising suddenly from a flat position to one almost perpendicular, etc. Sections 1 and 2 of the "Gardiner coal-field" (Plate LXXIX) are representative of the bed at the two principal openings on this side of the river, viz, at Major Horr's and Reese's, respectively. On the opposite or east side of the river is situated the only portion of this field that present developments indicate to be of value. Opposite Reese's ferry, a little back from the river, the coal croppings are found, one pit having been opened, affording the section given in Fig. 3 (Plate LXXIX). There are probably at least four seams of coal here, two close together, then about 150 feet of rock, then two more close together. The coal is of good quality, but just here worthless, for the d reason that within a hundred feet or so the Coal Measures and coal are cut off by granite forming the base of the high mountains rising from the river, as shown in Fig. 6. About a mile up the river Messrs. Gourley & Gillis have opened the coal to a slight extent, their pit affording the section represented in Fig. 4. This shows some good benches of coal, which is also of a good quality.

Over a mile farther up the river, at Eagle creek, the croppings are found again, and continue for half or three-quarters of a mile until the coal crosses into the Park. Fig. 5 is a section taken from this locality, on the east bank of the Yellowstone, opposite the mouth of Gardiner.

The only valuable portion of this field (as far as present developments show) extends from a little below Gourley & Gillis' pit to the Park line, a distance of from 2 to 2½ miles. Above and below Gourley's pit the outcrop is covered by trap-flows and travertine, and from Eagle creek to the Park line it is continuous. The Coal Measures, however, form only a narrow strip extending from the river back a short distance, probably not over three-quarters of a mile in greatest width, and generally much less. Except at the immediate outcrop the Coal Measures are covered by trap and travertine, and are probably cut off by a great trap-dike extending from opposite Cinnabar mountain to Bear gulch; hence even this portion of the field is of uncertain value, for it seems difficult to foretell how far the coal can be e followed down from the outcrop before being cut off by trap. Nearly all the seams furnish coal of excellent quality, black, hard, and square-jointed, giving evidences of coking qualities, and the pits on the portion east of the river show a thickness which, though not large, could probably be profitably worked.

This coal all occurs above the Colorado.

Another totally unimportant coal area occurs 9 miles east of Gallatin city, at the confluence of the three rivers forming the head of the Missouri. The coal lies in a narrow trough, the greatest width of any seam being about 18 inches. It is, furthermore, of the soft, friable, and "chippy" variety already noticed in the eastern part of the Bozeman field. This area is of no consequence whatever from an economic point of view. From the scientific side it merely adds another locality to the numerous Cretaceous coal areas of Montana.

THE MOUSE RIVER COAL-FIELD OF DAKOTA.

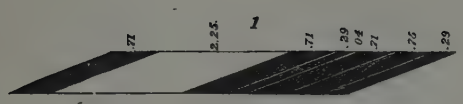
f

By reference to our general map (Plate LV), the area comprising the coal in this locality lies from 80 to 150 miles or more north or north-northwest from Bismarck.

The coteaus of the Missouri of an average width of 35 miles are seen having a northwest trend. Eastward they blend by a gentle slope with the broad expanse of level prairie, relieved only in its monotony of landscape by a low hill rising here and there abruptly for a few hundred feet. The surface of the prairies have a gradual fall eastward, as indicated by the flow of the rivers. Small lakes, both wet and dry, and still smaller ponds, lie scattered over the area. The sharply eroded valleys of the Mouse, Cheyenne, and James rivers cut the prairie to depths of from 75 to 150 feet, their former broad channels now constituting the rich bottom-lands, cut in turn by the meandering narrow streams of the present day. Along the Mouse river there is a special feature of topography in the long line of low sand dunes rising on both sides the river near its great bend and eastward.

From unpublished MS. 1

Plate LXXIX.



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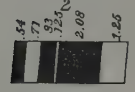
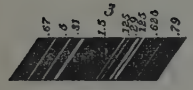
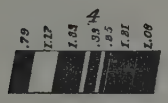
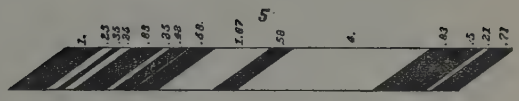
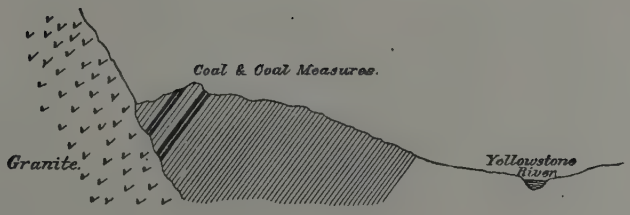




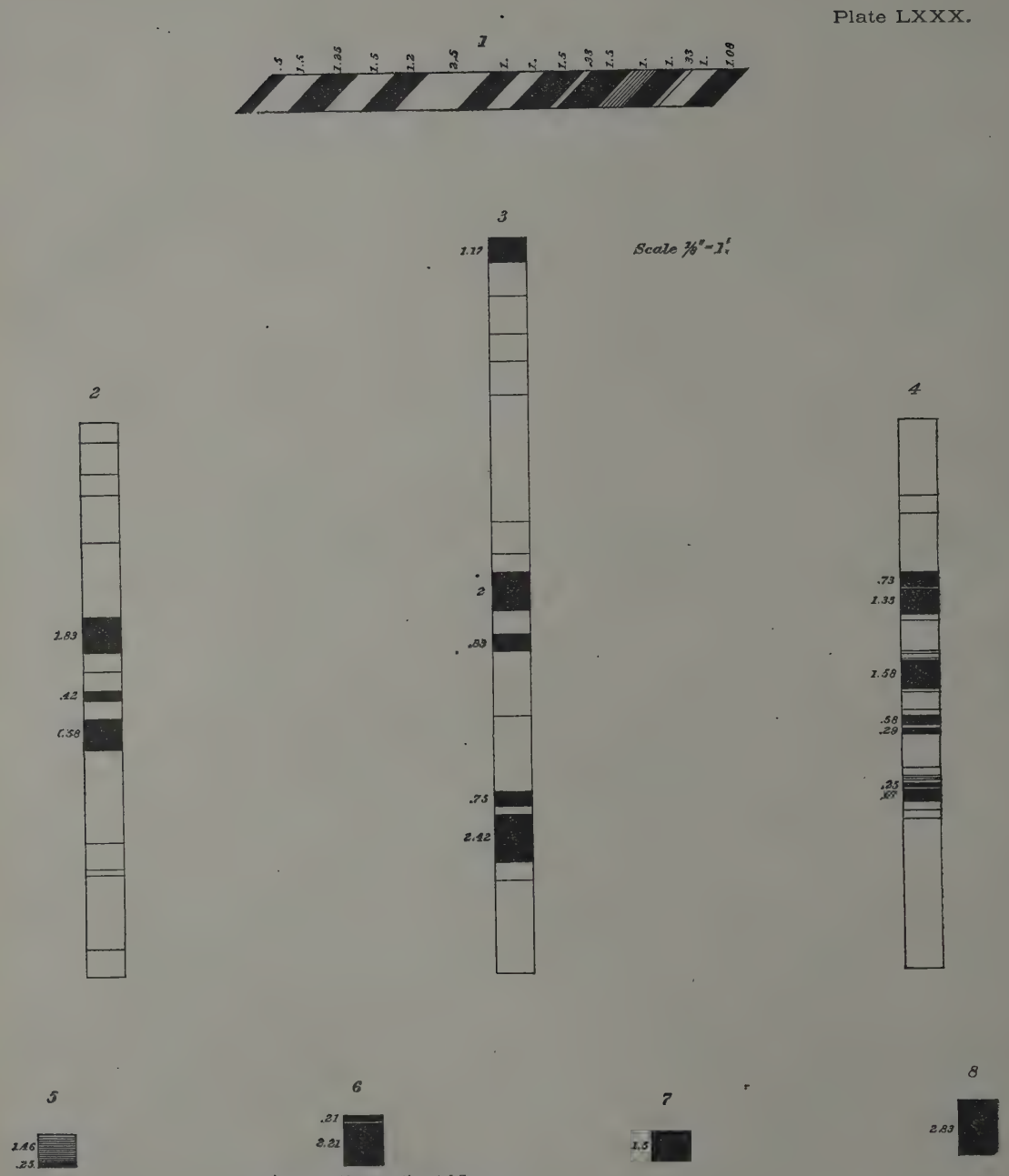






From unpublished MS. material of the Northern Transcontinental Survey.

SECTIONS OF COAL-SEAMS IN THE GARDINER COAL-FIELD. By J. E. Wolff.



From unpublished MS. material of the Northern Transcontinental Survey.

MISCELLANEOUS SECTIONS OF COAL-SEAMS. By Geo. H. Eldridge.

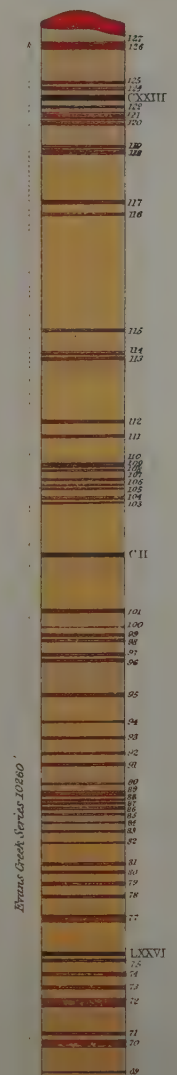
The strata carrying the coals of this region may all be referred to the lower part of the Laramie group, upon a both lithological and palæontological evidence. They consist, in ascending order, of heavily-bedded, coarse-grained sandstones, of gray color, and often ferruginous, containing thin, paper-like seams of lignite, the whole weathering easily. These are overlaid by other gray and yellow sandstones intercalated with clays, the former somewhat argillaceous, the latter arenaceous. Above these last come other purer drab clays, with some beds of sandstone, the latter being very variable in texture and their ability to withstand the weather. Many of the strata have a strong tendency to a concretionary structure. In the uppermost series of strata, just mentioned, the coal-seams are larger and the underlying clays thicker, and invariably of a leaden-gray color, except where, here and there, they are tinged chocolate from the lignitic matter contained in them. All the clays form bold and steep bluffs, and are a noticeable feature of the landscape where they occur.

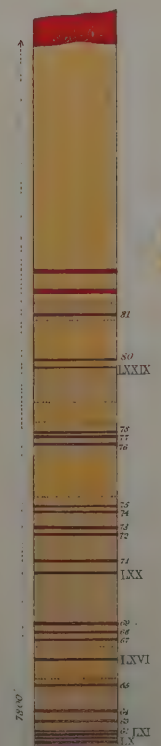
The Lower Laramie of this region contains only comparatively unimportant lignite-beds, the more important b ones occurring higher up in the series and to the southwest of our area of exploration, on the Missouri river, near Fort Stevenson and elsewhere, there being a dip of very slight amount toward a common center at Fort Union, forming there a great but very shallow synclinal basin.

The localities of the exposures of lignite are: 8 miles below the "Big bend" of Mouse river (Fig. 5 of the Miscellaneous sections, Plate LXXX); 25 miles above the Big bend, where the lignite is of comparatively fair quality, taken with the other lignite-beds of this locality (Fig. 6); another exposure of this seam a mile farther up the river (Fig. 7); 1 mile below the mouth of Lake river, a 6-inch seam, not figured; on Lake river, 40 miles above its entrance into Mouse river, a 30-inch and a 36-inch seam, the former very dirty, the latter much cleaner (the latter represented in Fig. 8 of the sections); with numerous thin seams of an inch or two scattered all along through the series. While, therefore, we have many seams of lignite, from one-half inch to 8 inches thick, e outcropping along the bluffs between the Big bend of Mouse river and the source of Lake river, and also two of a thickness of 2+ feet, but one workable bed of 3 feet was met with. The coal of this bed exhibits the usual characteristics of the poorer class of lignites, layers of the fibrous structure being intercalated with those of a homogeneous appearance and conchoidal fracture and a jetty luster. The entire seam contains much gypsum in the crystalline and powdered forms. The coal is by far the poorest observed during our explorations, and has no resistance whatever to the influences of weathering. It will, therefore, in all probability, never be used for other than domestic purposes by the future settlers of this river. Owing to the lay of the country, boring is the only means of determining the extent of any of the beds of lignite.

COLUMNAR SECTIONS
OF THE
PUGET SOUND COAL MEASURES
WASHINGTON TERRITORY.

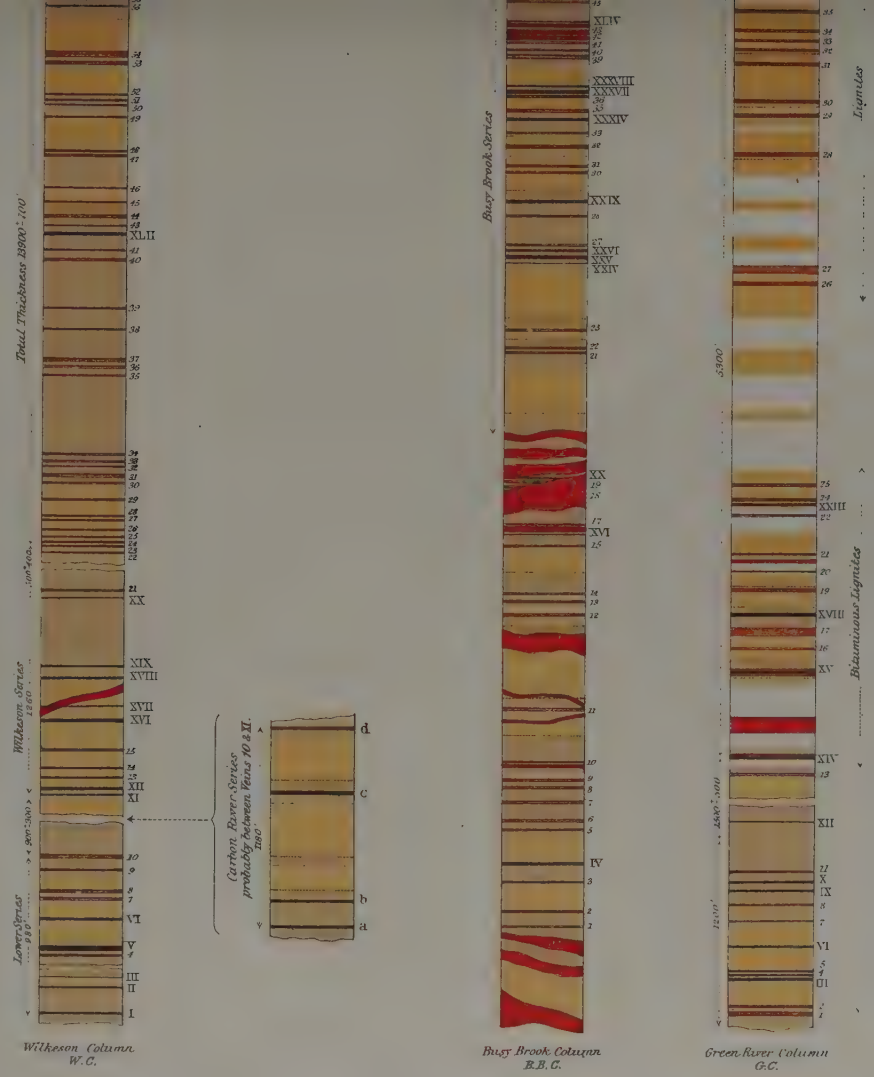
Surveys by R. E. Finley and F. J. Knight.
Geology by Bailey Willis.





Coal Beds
Black Slate Beds
Shale
Sandstone
Eruptive Rocks conformable to Coal Beds
" " un " " " " "

Scale 1000 Feet to 1 inch.



From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co Lith.

REPORT ON THE COAL-FIELDS OF WASHINGTON TERRITORY.

By Bailey Willis.

GENERAL GEOLOGY.

The Coal Measures of the Puget Sound basin consist of alternating beds of yellow and gray fine-grained sandstones and very fine gray arenaceous shales interstratified with many beds of carbonaceous shale and coal; the individual strata of sandstone and shale, from 20 to 200 feet thick, maintain the same general character wherever observed, and no well-defined horizon has been found which might serve as an index to correlate the widely-separated exposures. Leaf impressions occur in both shales and sandstones associated with unios. Collections made by the Northern Transcontinental Survey have been submitted to Professor J. S. Newberry, who considers them the equivalent of the Laramie east of the Rocky mountains, and of greater antiquity than the Tertiaries of Bridge creek and John Day's valley in eastern Oregon; these collections relate, however, principally to the lower measures of the Wilkeson field of bituminous coal, and it remains to be seen whether further evidence, now being gathered, will sustain the inference, drawn from stratigraphical relations, that the lignites and bituminous coals belong to one age.

The thickness of the Laramie group, as determined by Mr. George H. Eldridge in Montana, is about 8,500 feet in the Bull mountains, and very much less near the old shore-lines. On the Pacific coast it greatly exceeds the above maximum, but it is not possible without further study to state even an approximate total, on account of the uncertain relations of the much-disturbed strata, obscured by volcanic flows, recent drift, and a dense forest.

The best sections are those obtained in the Wilkeson and Green River fields, and described in detail in their proper connection, though even they are incomplete; of these one gives a minimum of 13,200 feet, with a probable maximum of 14,500 feet; a second, still less complete, measures 7,700 feet; and the third, on Green river, lies between 6,200 and 8,200 feet; and these sections do not in either case reach the limits of the Coal Measures, as the base of each is an anticlinal axis and the top the highest exposure, geologically speaking, beneath the volcanic flows or drift-beds. Such figures challenge confirmation, but they are the result of accurate surveys and careful observation, and are only invalidated by the possibility of undiscovered faults, of which the sections have yielded no proof under close examination.

The fossils indicate the maintenance of fresh- and brackish-water conditions through this long period of deposition, implying that the general rate of this profound subsidence was the same as that of accumulation of sediments.

The circumstances of deposition were subject to frequent and probably often local changes; the preponderance of layers of fine sandstone, apparently derived from granite, suggests clear currents and pools, existing cotemporaneously with shallow waters and marshes, in which muddy sediment and peat accumulated; and the succession of sandstones, shales, and coal-veins in the column of strata indicate as many changes of depth and current over the same locality. In the first of the above-mentioned sections there are 127 carbonaceous beds, of which 17 are workable coal-veins 3 to 15 feet thick.

Outcrops of older rocks in the vicinity of these Coal Measures are usually of granite or crystalline schists, either serpentine or chloritic; in the San Juan archipelago there are evidences of Cretaceous strata, and a hint of their existence is found in some indistinct agatized casts, of oval cross-section and about 2 inches long, which were brought from a conglomerate on the upper Skookumchuck southeast of Tenino; they were unfortunately lost, but were apparently casts of baculites. These would seem to be the edges of a Cretaceous deposit, hidden beneath the more extensive later rocks. But one contact of the Coal Measures with underlying schists has been observed, and that is of uncertain character; its two interpretations are given in the accompanying diagram (Plate LXXXII). The first shows a plane of unconformable deposition tilted to a dip of 45°; the other presents the alternative of a fault.

a I was unable from the contact exposed to determine which view is correct, and I had no opportunity to trace it out. It is probable that the first coal-bearing rocks were laid down upon a surface composed of areas of granite, schist, and Cretaceous conglomerate.

The region over which this deposition occurred has since been the scene of mountain-making upheaval, of stupendous volcanic eruptions and enormous erosion, both glacial and subaërial. The definition of its boundaries and extent is a correspondingly difficult, perhaps in some directions impossible task.

Looking at the Puget Sound basin as a whole, the Coal Measures extend from beyond the British boundary south almost to the Columbia, and from the Pacific ocean eastward up onto the Cascade range to elevations varying from 800 to 5,000 feet above the sea; but buried on the one hand beneath recent gravel-beds, and overflowed on the other by erupted masses, the visible part of the formation appears as an interrupted belt along the base of the b Cascades and encircling the Olympic mountains.

The Bellingham Bay lignite mines, which were known in 1851, and shipped 20,500 tons to San Francisco in 1869, but were shut down in 1878, are opened on an isolated outcrop surrounded by a region of forest-covered drift-beds. Their nearest associated coals are to the west, on Vancouver's island, and southeast at the "Coal mine", on the Skagit river, 40 miles from its mouth. The latter covers a small area south of the Skagit. It is bounded on the east by a contact with crystalline schists, which extend far northwest of Mount Baker; on the west and south by drift-beds, and on the north the coal is lost beneath the swamp-lands along the river. This coal is of bituminous character, and quite different in chemical composition from the inferior lignites which crop out on both branches of the Stilaguamish river.

From the latter, southward, there is a region little known geologically, over which the drift-beds extend up to c the outliers of the Cascades, and the Coal Measures appear, if at all, only as a very narrow strip, until they are exposed in the cañon of Green river. Within this stretch, however, are the disconnected outcrops on which the Newcastle and Renton mines are sunk, 15 miles southeast of Seattle. Both of these mines produce an excellent lignite, which does not air-slack. Between them and the Green River field is the outcrop of a vein, called the McAllister, on Cedar river.

Green river cuts through the Coal Measures from east to west for about 9 miles, in a straight line, but much farther by the river, giving a section from the contact with eruptive rocks on the east to the drift-beds on the west. This section includes coals generally called bituminous, which produce a fragile coke, but have a lignitic luster, and very poor typical lignites, the latter overlying the former in the western portion of the section. The field is bounded north, west, and south by overlying drift, which extends 20 miles in the latter direction, to the most northern d outcrops of the Wilkeson coal. This is a soft, coking, highly bituminous coal, jet black, and of cubical fracture, which produces a strong, close-grained, sonorous coke. Its general character is maintained throughout the field from Wilkeson south to the Nisqually river, about 24 miles, except where it is locally altered to semi-anthracite or columnar coke by the action of intruded rocks. The field is from 1 to 6 miles wide, and is limited on the east by the volcanic rocks of Mount Rainier and its lesser craters, and on the west by eruptive rocks, which 30 miles west of Mount Rainier form an unnamed group of mountains 5,000 feet high.

Still west of these little known heights, and south of Puget Sound, is the most extensive lignite area in Washington territory. It reaches from Castle Rock station, on the Northern Pacific railroad, north to the Sciatco mines on the Skookumchuck river, and northwest to the Olympic range, along the Upper Satsop river. Its eastern boundary is where the lignite measures join the volcanic rocks which separate them from the coking coal of the e Wilkeson field, but the lignite remains unaltered up to the contact. The proximity of this field to the line of the railroad has led to its being carefully prospected. Wherever the veins have been opened they produce a bright, clean lignite, which air-slacks and possesses a low heating power.

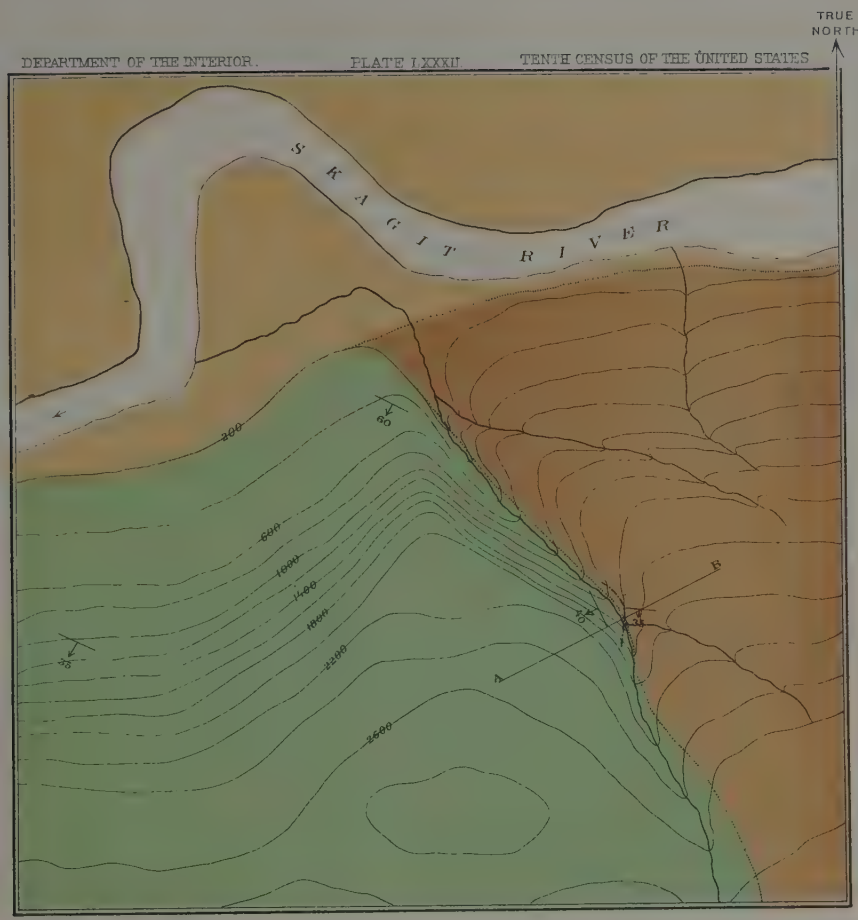
The Olympic range, composed of granite, crystalline schists, and volcanic rocks girt by recent drift, has been so little explored it is not possible to define the limits of the Coal Measures on its slopes; but besides the localities mentioned on the south and southwest, they occur on Clallam and Pysche rivers on the north, and probably at other points about the foot-hills.

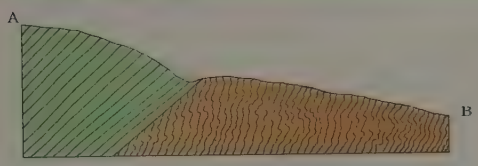
The geological section of the Puget Sound basin as developed in the exploration of these coal-fields may be provisionally stated as follows:

(1) Present surface of humus, accumulating from the beds of *Hypnum splendens* and the contributions of ferns, f shrubs, and evergreens of the damp, luxuriant forest; average thickness probably 4 inches, though frequently wanting, where fires have occurred within two centuries.

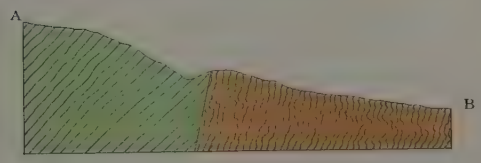
(2) Beds of coarse and fine gravel, sand, and clay, intimately mingled and distributed by swift currents; composed almost wholly of hard volcanic material, highly polished, and sometimes striated. These drift-beds fill the deeply-eroded valleys of all the rivers entering the sound to an unknown depth; they form well-defined terraces at Wilkeson, 1,600 feet above the sea, with a known thickness above the solid rock of 300 feet, and occur in terraces at an elevation of 2,000 feet on the western slope from the Natchez pass.

(3) Tertiary volcanic rocks, which form the highest peaks of the Cascade range (Mount Rainier, 14,300 feet), and detached mountain masses and ridges. They occur as intrusive dikes in the Coal Measures, often with an appearance of conformability, and as flows beneath which the coal-rocks disappear.





UNCONFORMABLE DEPOSITION



FAULT

Drift

Coal Measures

Schist

Scale: 2″=1 mile.

Topography by R.C. Templeman.

Geology by Bailey Willis.

CONTACT OF COAL MEASURES AND SCHISTS
NEAR SKAGIT COAL MINES, WASH. TER.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

(4) The lignitic and bituminous Coal Measures, sandstones, and shales probably exceeding 13,000 (?) feet in a thickness; Laramie?

(5) Cretaceous strata of the San Juan islands and conglomerate? of the Skookumchuck.

(6) Serpentine or chloritic schists associated with limestones and marble beds, containing segregated auriferous quartz veins, and on the Skagit silicious specular iron ore. These highly metamorphosed strata form with granite the mass of the Cascade range, and are similar in association to the same rocks in northern Washington territory and those of western Idaho; they are pre-Cretaceous and possibly Paleozoic.

Granite covers a large area west of the crystalline schists of the Skagit, reaching beyond Lake Chelan to the Okinakane and eastward to the Colville region, though sometimes hidden beneath more recent material.

Turning to the eastern slopes of the cascades there appears a small development of Coal Measures similar to b those of the Puget Sound basin near the head of the Yakima river and on the Wenatchie river; they crop out near Lake Kitchelas, Lake Klealim, and on Schwak creek, a small tributary of the Yakima from the north; they are of limited extent and probably not more than 1,000 feet thick. They rest conformably (?) upon 7,000 or 8,000 feet of coarse sandstone containing thin layers of conglomerate, at the base of which is a bed of coarse conglomerate 300 to 400 feet thick; the best exposures of these rocks are south of the Wenatchie on the spur of the Cascades, called the Peshastan range which divides that river from the Yakima. The same sandstone and conglomerate beds occur at the head of the Munastash creek, 25 miles west of Ellensburg, at an elevation of 5,500 feet on the main Cascade range. The probability that these strata east of the range correspond to the Coal Measures west of it is suggested in the following comparison of sections: c

West of the Cascades.	East of the Cascades.
(1) Wide-spread glacial drift.	(1) Limited glacial drift. Lake beds of the Yakima and Columbia rivers.
(2) Tertiary volcanic rocks.	(2) Tertiary volcanic rocks.
(3) Lignitic and bituminous Coal Measures, characterized by angiospermous leaf impressions throughout the entire thickness, 13,000 feet or more.	(3) Coal Measures of limited extent, 1,000 feet ±. Coarse sandstone with thin conglomerate beds, 7,000 to 8,000 feet. d
(4) Cretaceous strata and conglomerate of the Skookumchuck.	(4) Conglomerate, 300 to 400 feet thick.
(5) Serpentinic or chloritic schists, associated with limestone and resting on granite; common to both sides of the range.	

The extent of the Cretaceous strata requires further study, but the existence of Laramie (?) sandstones upturned high upon the mountains places their upheaval at the close of that period.

TABLE 45.—*Analyses of representative samples of Washington territory coals and lignites.*

	LIGNITES.					BITUMINOUS LIGNITES.							e
			Green River field, Washington territory.										
	Miles City, Dakota.	Newcastle, Washington territory.	Vein (?) G. R. C.	Vein 33 G. R. C.	Vein (?) (G. R. C.).	Vein XVIII G. R. C.	Vein IX G. R. C.	Vein VI G. R. C.	Vein III G. R. C.	Upper Yakima river, Washington territory.	Carbon Station, Wyoming territory.	Rock Springs, Wyoming territory.
Original sample number	79	24	59	56	50	27	42	43	45	.....	.....	.....
Moisture	14.10	4.16	7.27	9.98	8.68	2.50	4.82	3.34	3.24	0.80	8.10	7.00
Volatile hydro-carbons	36.95	44.84	36.02	40.63	35.90	45.71	42.02	39.39	39.52	40.87	34.70	36.81
Fixed carbon	35.76	43.86	28.48	41.07	47.07	48.37	37.12	41.49	48.39	46.39	51.65	54.46
Ash	13.19	7.14	28.23	8.32	8.35	3.42	16.04	15.78	9.85	11.94	5.55	1.73
F. C. / V. H. C.	0.97	0.98	0.79	1.01	1.31	1.06	0.88	1.05	1.22	1.18	1.48	1.48
Coke	None.	None.	None.	None.	None.	Poor.	None. (a)	None. (a)	Worthless	Fair.	.....	.....

a TABLE 45.—*Analyses of representative samples of Washington territory coals and lignites*—Continued.

b	BITUMINOUS COALS.										
	Wilkeson field, Washington territory.								Skagit river, Washington territory.	Raton, New Mexico.	El Moro, New Mexico.
							Altered by intrusive rocks.				
	Wingate vein, carbonado.	Vein CXXXIII W. C.	Vein XVIII W. C.	Vein V W. C.	Vein I W. C.	Vein LVIII B. B. C.	Vein XLIV B. B. C.	Vein d, Carbon river W. C.			
Original sample number	12	125	17	64	37	136	135	68	76	.....	.....
Moisture	1.80	3.98	1.33	1.16	1.54	0.61	0.44	2.56	1.17	2.0	1.66
Volatile hydro-carbons	42.27	28.64	25.88	29.09	28.17	29.58	5.84	8.43	14.40	37.1	34.48
Fixed carbon	52.11	54.10	60.67	60.38	59.70	56.18	73.98	83.27	64.56	51.6	60.08
Ash	3.82	13.28	12.12	9.37	10.59	13.63	19.74	5.74	19.87	9.3	3.78
F. C. / V. H. C.	1.23	1.88	2.34	2.07	2.12	1.89	12.67	9.87	4.48	1.39	1.74
Coke	Very good.	None? (b)	Excellent.	Excellent.	Poor? (b).	Black and friable.	None.	None.	Rather poor.	Good.	Good.
c											

a Produced fragile coke in field test. b Produced first-class coke in field test.

NOTE.—G. R. C., Green River column; W. C., Wilkeson column; B. B. C., Busy Brook column. See columnar sections of Coal Measures. Analyses of coal from Carbon Station, Rock Springs, Raton, and El Moro taken from *Mineral Resources of the United States*, by Albert Williams, jr., United States Geological Survey, 1883.

Sample 79, taken from outcrop of typical lignite-bed on Sunday creek, near Miles City, Dakota. Sample 24, taken from end of gangway, 400 feet below the surface, represents cross-section of vein 12 feet thick. Samples 59, 56, and 50, taken from the outcrop. Sample 27, McKay vein, 5 feet thick, taken from prospect tunnel, 20 feet below the surface. Samples 42, 43, 45, average samples from outcrops faced down. Sample 12, average sample from end of gangway, 150± feet below the surface. Samples 125, 17, 37, 136, 135, average samples from outcrops faced down. Sample 64, average sample from tunnel, 30 feet below the surface. Sample 68, picked sample from outcrop. Sample 76, picked sample from Prospect tunnel, 10 feet below the surface.

d The coals of Washington territory range in quality all the way from lignite, which still retains a woody structure, to anthracite. In the above table a number of representative analyses are given, and those of some similar coals of Wyoming and New Mexico are added for comparison. The "lignites", "bituminous lignites," and "bituminous coals" grade into each other, but they may here be defined to mean—

Lignite, a coal of brilliant luster, conchoidal fracture, brown streak, homogeneous or woody structure, which cracks into small, irregular fragments when exposed to changes of temperature and moisture, and which does not coke.

Bituminous lignite, a coal of lignitic luster and streak, homogeneous structure, irregular, slightly conchoidal fracture, which does not air-slack, and forms a more or less fragile coke.

The Newcastle, Washington territory, lignite is intermediate between these two classes. It does not air-slack,
e but, on the other hand, it does not coke, and it is known in the Pacific coast markets as a high-grade lignite.

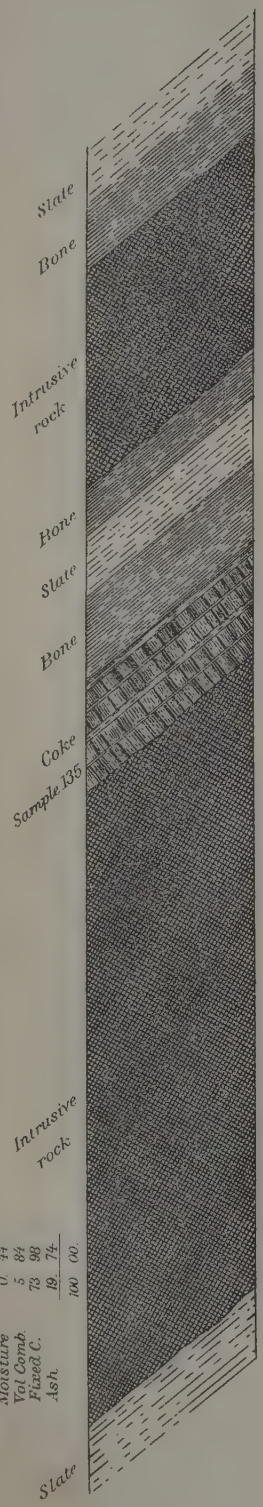
Bituminous coals have a black streak, more or less cubical fracture, and coke strongly, forming a sonorous, close-grained coke.

The coking quality of a coal is of practical importance in relation to the value of the fine material, particularly when, as is the case in the Wilkeson field, the coal is soft, and it gives a means of determining, in the course of primary exploration, the probable chemical character of the beds discovered. I have calculated the ratio $\frac{\text{F. C.}}{\text{V. H. C.}}$, suggested by Professor Frazer, in Vol. MM, *Second Geological Survey of Pennsylvania*, as a basis for classification, in order to show the relations of the bituminous coals and their altered products to the eastern coals. Professor Frazer's classification is:

f

	$\frac{\text{F. C.}}{\text{V. H. C.}}$
Hard, dry anthracite	100 to 12.
Semi-anthracite	12 to 8.
Semi-bituminous	8 to 5.
Bituminous	5 to a fraction.

No. 68 is therefore a semi-anthracite; and No. 135 corresponds to hard, dry anthracite, but it is more truly a natural coke, since it has a somewhat cellular structure and occurs in polygonal columns 3 or 4 inches long and ¼ to ½ inch diameter, which lie at right-angles to the heating-surface of intrusive rock. Both of these are purely local results.



ANALYSIS OF COKE SAMPLE 135.

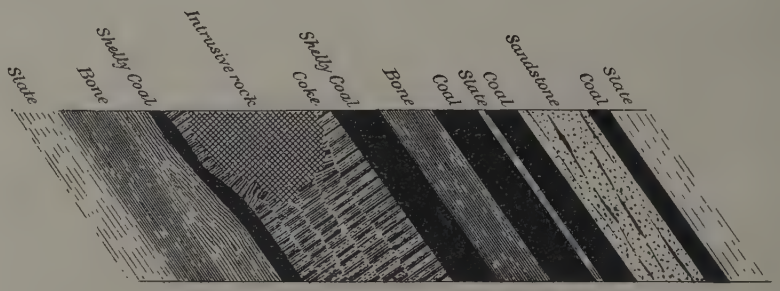
Moisture	0. 44
Vol Comb.	5 84
Fixed C.	73 98
Ash	19. 74
	100 00

WILKESON COALFIELD.

Vein 44 Busy Brook
Coal altered to columnar coke by intrusive rock conformable to the bedding. Scale 1/60. Drawn on observed dip.

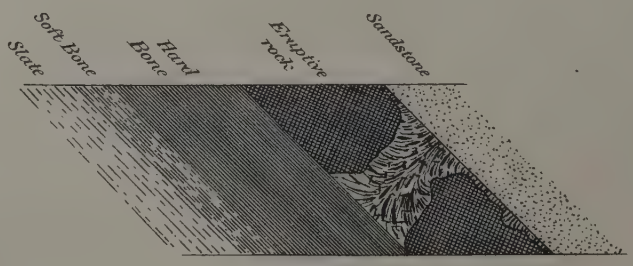
GREEN RIVER COALFIELD.
Washington Ter.

Intrusive dyke and coal bed observed near the eastern limit of the field. Scale 1/120 Drawn on observed Dip.



WILKESON COALFIELD.

Vein XXIX Busy Brook
Coal altered to columnar coke by intrusive rock
Scale 1/60 Drawn on observed dip.



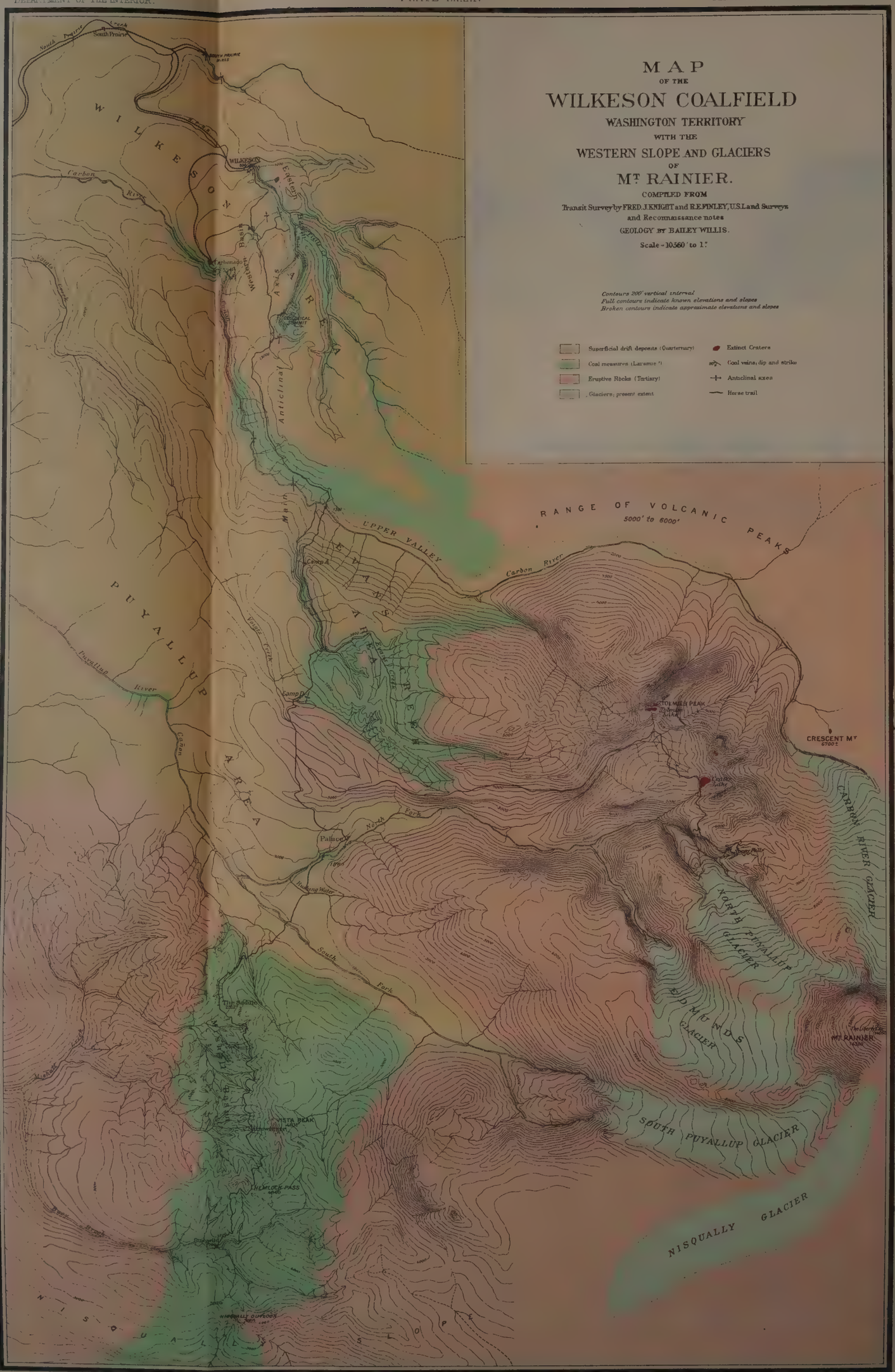
WILKESON COALFIELD.

Vein 47 Busy Brook
Coal bed replaced by eruptive rock which encloses a mass of columnar coke
Scale 1/60. Drawn on observed dip.

Bailey Willis del.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.


MAP
OF THE
WILKESON COALFIELD
WASHINGTON TERRITORY
WITH THE
WESTERN SLOPE AND GLACIERS
OF
Mt RAINIER.
COMPILED FROM
Transit Survey by FRED. J. KNIGHT and R. E. FINLEY, U.S. Land Surveys
and Reconnaissance notes
GEOLOGY BY BAILEY WILLIS.
Scale = 10560' to 1"
Contours 200' vertical interval
Full contours indicate known elevations and slopes
Broken contours indicate approximate elevations and slopes
Superficial drift deposits (Quarternary)
Coal measures (Laramie ?)
Eruptive Rocks (Tertiary)
Glaciers; present extent
Extinct Craters
Coal veins; dip and strike
Anticlinal axes
Horse trail
WILKESON
Carbon River
Eastern
Western Branch
Anticlinal Axis
WILKESON AREA
PUYALLUP AREA
Puyallup River
Carbon
Voigts Creek
Camp A
Camp D
UPPER VALLEY
Carbon River
RANGE OF VOLCANIC PEAKS
5000' to 6000'
STOLMEIER PEAK
CRESCENT Mt
6700'
Carbon River
North Fork
Palace
Flowing Water
South Fork
CARBON RIVER GLACIER
NORTH PUYALLUP GLACIER
EDMUNDS GLACIER
SOUTH PUYALLUP GLACIER
NISQUALLY GLACIER
Mt RAINIER
VISTA PEAK
THE WALDEN PASS
NISQUALLY OUTLOOK
NISQUALLY SLOPE

It will be noticed that the above ratio affords no criterion for distinguishing between lignites and more a bituminous varieties of coal, since the classes overlap each other; in stages of alteration bordering on lignite the percentage of combined and hygroscopic water is of more importance than the relation of hydrocarbons to the fixed carbon of the coal.

The differences of character of the Washington territory coals are ascribed to three principal causes: differences of age, the influence of volcanic rocks, and the metamorphic action incident to the crumpling of the strata.

The fields which have been wholly or partially modified by these causes are the Wilkeson, the Green river, and the Skagit; separated from each other and from the lignite areas by broad stretches of drift and by volcanic flows, they afford no data from which their relations might be deduced, except the lithological characteristics and fossils of their strata.

The similarity of composition and interbedding of the sandstones and shales, wherever they have been b observed, points, so far as it goes, to identity of age, and considering the great thickness of the sections measured in the different fields, it is difficult to believe that they can be superimposed to the extent necessary to account for the varieties of coal. The fossils, so far as they have been examined, belong to one period.

The great thickness of strata in the Green River and Wilkeson fields justifies us in expecting differences between the upper and lower coals in either section; and the expectation is apparently borne out in the former field, where the upper veins are of typical and rather inferior lignite, and the lower are bituminous lignites. But the poorer lignites are at the same time confined to the least-disturbed portion of the field, and the more bituminous beds are very similar in composition throughout the lower 3,000 feet of the series, which have suffered a uniform faulting and folding. This evidence applies equally, therefore, to supposed differences of age or the differences of metamorphism. c

The same is true of the Skagit coal, which may on the one hand be the lowest portion of the Coal Measures known in close contact with the schists, upon which it was deposited, or, on the other hand, a bed belonging anywhere in the coal series, modified by proximity to a very extensive fault.

The thickness of the strata measured in the Wilkeson field is double that of the Green river, and the differences of composition between the upper and lower coals should be correspondingly greater. They are indicated in samples 125, 17, 64, and 37, from the highest, intermediate, and lowest beds, and they are practically *nil*. The identity of character points to the conclusion that some stronger influence has destroyed differences we might justly expect in coals separated by such intervals of deposition.

Volcanic rocks occur in contact with the Coal Measures as flows and as intrusive dikes. They have modified the character of the coal by pressure and heat, and the influence of a superficial flow would, in both these respects, be d less than that of the molten rock before extrusion. Coal-beds altered by dikes in their immediate vicinity are frequent in the Wilkeson field, but in every such case the alteration is confined to a few hundred feet on either side of the contact. Thus, sample 68 represents a vein cropping out in close proximity to the great fracture which bounds the Wilkeson field on the west, south of Carbonado. The dike is known to be a mile wide, and it joins other flows and dikes to the westward. But this same bed of coal, here altered to semi-anthracite of brilliant luster and anthracitic fracture, produces coking coal of the character common to the whole field less than a quarter of a mile from this outcrop, and "Bed C, Carbon river, W. C.", separated from it by but 500 feet of shale and sandstone, is unaltered. Sample 135 was taken from between walls of volcanic rock within 750 feet of the bed represented by Sample 136.

A cause so local in its action, under the most favorable conditions, could not have produced the widespread e and uniform differences between the Wilkeson, Green river, and lignitic coals.

Great differences of age being improbable, and the influence of volcanic rocks being purely local, we may justly compare the modern lignite and its concentrated products with the Carboniferous coals of Ohio and their modifications in the Pennsylvania and Rhode Island anthracites. Thus the lignites are usually horizontal, and where they are disturbed the flexures are broad, even where the dips are considerable. In the Green River field the bituminous lignites are sharply flexed and faulted and the dips are frequently vertical, but within the veins themselves there is little evidence of movement. The Wilkeson bituminous coal-field is folded into long narrow troughs of great depth, with dips ranging from 50° to 90°; small throws and large faults, slicken-sides, and balls of crushed coal, bear witness to the mechanical pressure the Measures have been subjected to. The concentration of the coal is throughout in proportion to the degree of flexure and evidence of movement in the Coal Measures, and the relation between f the chemical character of the coal and the complexity of the structural geology justifies the conclusion that they are the common result of that force, which closed the lignitic period with the elevation of the Cascade range.

THE WILKESON COAL-FIELD.

Position and boundaries.— This field, as now known, is an isolated strip of Coal Measure strata, extending north from the Nisqually river, in township 15 north to township 19 north, and within range 6 east of the Willamette meridian. Wilkeson, the place of first discovery of the coal, and the end of the branch road built by the Northern Pacific Railroad Company to the coal-mines, is near the northern end of the field, 31 miles by rail southeast of Tacoma

a on Puget sound. Carbonado, the town erected at the mines of the Central Pacific Railroad Company, is about 3 miles southwest of Wilkeson on the edge of Carbon River cañon, and near the western border of the coal-field. South Prairie creek, 2 miles north of Wilkeson, and on which the South Prairie mines are opened, may be considered the northern boundary of the field, since it disappears to the northward under the drift of the White River plain and valley, which is only interrupted by a few outcrops of volcanic rock. Thus defined the Wilkeson coal-field is about 27 miles long north and south, and from 1 to 6 miles wide east and west, with an area of approximately 100 square miles, of which perhaps one-fifth can be developed and made profitably productive. As stated, the northern boundary is somewhat indefinite, but its eastern, southern, and western limits are absolute contacts with erupted mountain masses, in which this slender strip of sedimentary rocks has been almost engulfed. These contacts are nevertheless seldom to be observed since glacial deposits and forest growth bury all solid rock below 5,000 feet b under a covering that only patient work with axe, pick, and shovel can penetrate. Only in the bold walls of the lower cañons of Carbon river, of the Puyallup and Mishall creek, and on the high summits of the volcanic peaks are there any outcrops. I have therefore not attempted to give absolute boundaries on the geological map, although the coloring is a close approximation to exactness.

Topography.—The topography of the Wilkeson field is the result of several volcanic uplifts, of subsequent glacial conditions and subaerial erosion, working in material of widely different degrees of hardness; its character may be justly described as extremely mountainous; slopes are steep, valleys narrow, and elevations that rise 1,000 to 3,000 feet above them, the rule within the Coal Measure area.

On its eastern border is mount Rainier, towering to an elevation of 14,300 feet; 7,000 feet above the crest of the adjacent Cascade range, and 8,000 to 9,000 feet above the mountains on the northwest and south. From the c flanks of this grand mountain a chaotic chain of lesser volcanic peaks extends a little west of north about 20 miles, falling away toward Wilkeson, and drained mainly by South Prairie creek. Another spur reaches out from Rainier to the southwest, between the Cowlitz and Nisqually rivers, and the whole volcanic range forms at once the eastern and southern geological and topographical boundary of the coal-field. This uplift, which probably was among the earliest manifestations of Tertiary eruptive force in the region, determined the northward course of White river, the flow of the several branches of the Puyallup and of the Nisqually toward the west, and of the Cowlitz to the southwest. Of these, the Puyallup and Nisqually now drain the coal-field, their main streams and principal tributaries cutting across it from east to west at right-angles to the general trend of the anticlinal and synclinal axes. In their descent from Rainier to the sound, the Nisqually, the Puyallup, and Carbon river (formerly called the North fork of the Puyallup), each passes through three valley phases. There is on each an upper valley, beginning d with the terminal moraines of the glaciers on Rainier, and extending 20 to 35 miles down stream; hemmed in between dark precipices near the mountain, these valleys widen to 300 yards on Carbon river, and to 1 to 2 miles on the Puyallup and Nisqually; where narrow, the river-bed is but a strip of gray boulders between steep, densely-timbered mountain sides; where wider, the bottom-lands are forest clad, and the slopes of the mountains are contoured by terraces. From these upper valleys the rivers plunge into narrow cañons, with vertical or overhanging walls of sedimentary and eruptive rock; the cañon of Carbon river is 2½ miles long, with a greatest depth near its lower end of about 250 feet; it is often but 40 to 50 feet wide, and through part of its course exposes an interesting section of recent volcanic rock, underlying the Coal Measure strata it has upheaved, but at that point not broken through. The cañons of the Puyallup and Nisqually are similar, but deeper and longer; lying far outside the valuable coal region, they were not closely studied. These cañons are cut through a probably volcanic uplift e later than that of Rainier; the uplift itself may have obliterated the former river-courses and have forced the cutting of the new channels, or the diversion of the rivers which resulted in these cañons may have been the effect of stoppage of former courses by drift of the much later glacial period.

The region of maximum activity of this secondary uplift appears to have been west of the Nisqually, where a group of mountains reaches a height of 5,000 to 6,000 feet; they have never been mapped, but the western slope is drained by the Deschutes, Newaukum, Skookumchuck, and Tilton creek.

The third phase of these river cañons is that of their lower valleys; level bottom-lands, 1 to 3 miles wide, bounded by terraced hills of drift which lead down to the deltas, forming very rapidly where tide and river meet. The great depth to which these valleys have formerly been excavated, as evidenced in the depth of the Sound basin, is proof of elevation probably of much later date than those disturbances that produced the structure of the f Wilkeson coal-field.

The glacial period has added its chapter of great interest to that of the volcanic phenomena. Drift is almost the universal superficial deposit; it forms the shores of the sound and fills the valleys to their present levels; it reaches far up on the slopes of the Cascades and of Rainier and merges with the terminal moraines of the diminished glaciers. Its presence in the area of the coal-field results in gently-sloping plateaus and abrupt terraces. From the several terraces above Wilkeson a gentle ascent extends southward to the steep descent into the Upper Carbon River valley, and beyond it a continuation of apparently the same rising plateau reaches south to the ridge above Evans creek to an elevation of about 3,000 feet. This whole surface, composed entirely of drift, was probably continuous with the general sheet which reaches out to the north and west and is interrupted by Flett's creek and South

IDEAL SECTION OF THE WILKESON COALFIELD.

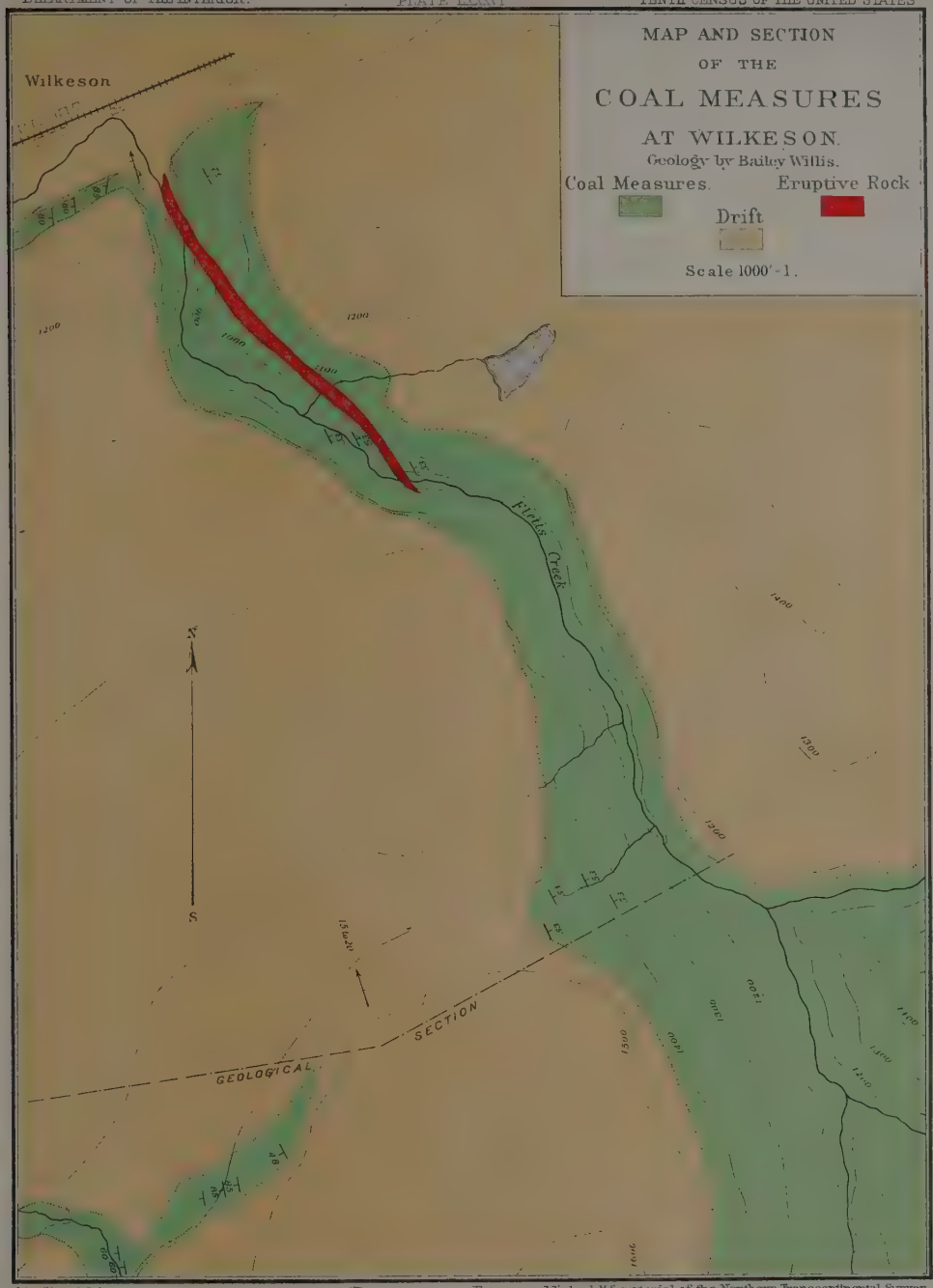
FROM WILKESON TO THE PUYALLUP RIVER 14 MILES ALONG THE GREAT ANTICLINAL AXIS, SHOWING THE PITCH.

By Bailey Willis, Northern Transcontinental Survey.

Scale: 2 Miles = 1 Inch.

From unpublished M.S. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.



Julius Bien & Co. Lith.

From unpublished MS. material of the Northern Transcontinental Survey.

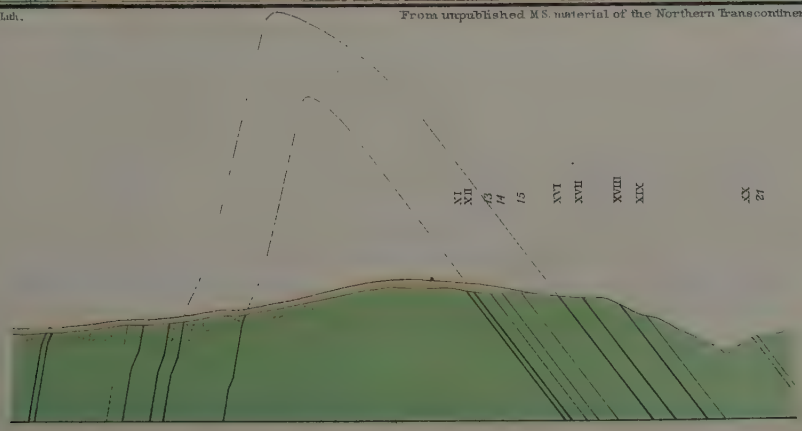
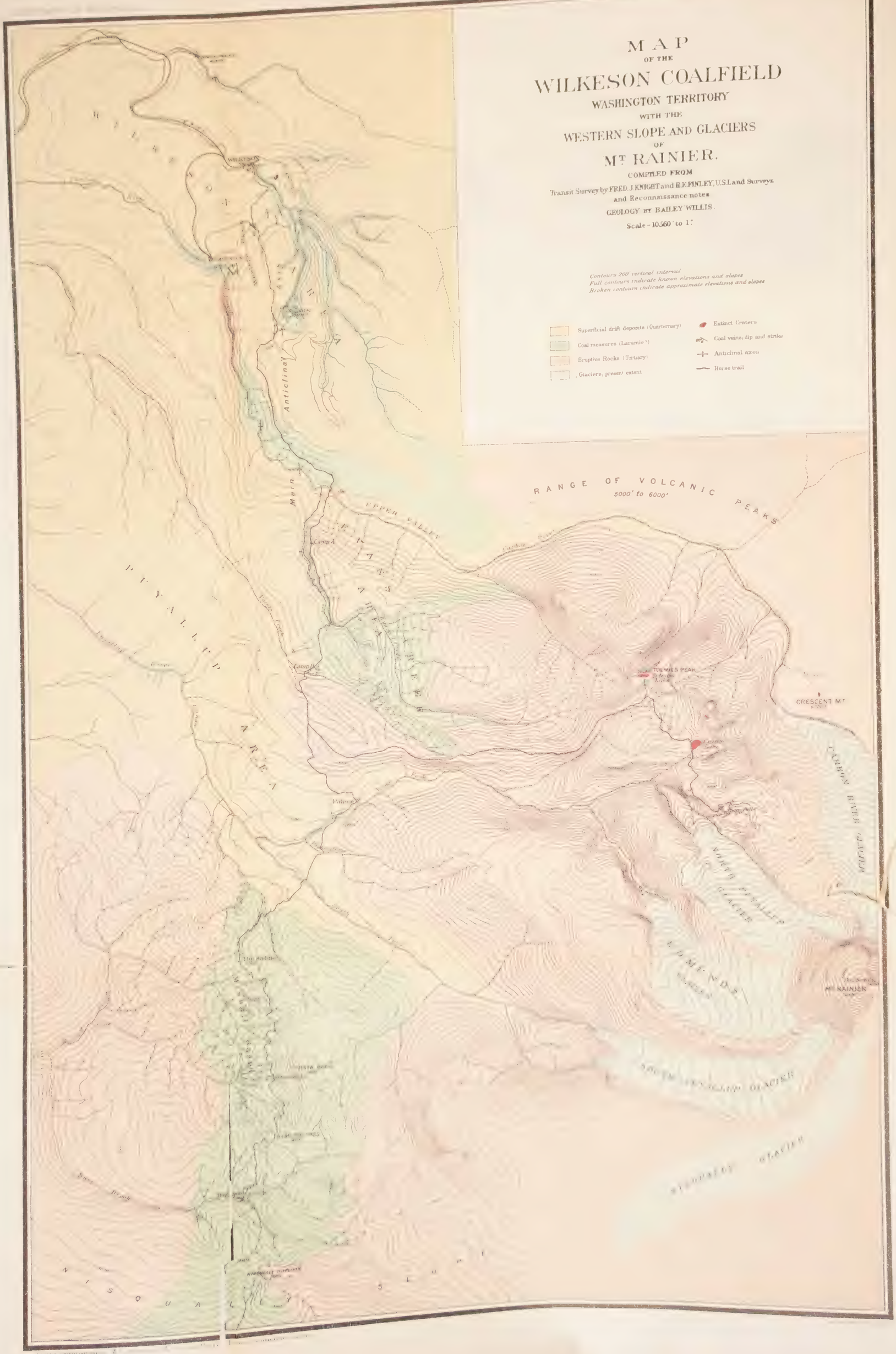


PLATE LXXXIV



LXXVII

WASHINGTON TERRITORY

ON BUSY BROOK IN THE NISQUALLY AREA.

THE VOLCANIC FLOWS FROM RAINIER ON THE EAST.

Scale { North of Transc Survey

Feet to 1 Inch

Julius Bien & Co Lith

WILKESON COALFIELD

GEOLOGICAL SECTION, MEASURED

FROM THE BOUNDING DYKE ON THE WEST TO

Surveys by E. J. Knig

Geology by Dunbar S

Scale 3

NOTE. The Section is based on observations in coalworks described in detail in Reports of the Inspectors; sandstones and shales are therefore only an approximate representation of their relative distribution.

Sandstone

Shale

Coal

Bony Beds

Volcanic Rock

reek, but which, farther north, sinks far beneath the excavation of present drainage lines. The glacier a
ade this widespread deposit has left its marks on the rocks of Tolmies peak and the highest slopes of
In the terraces above Wilkeson the drift has a depth of 300 feet, as proved by tunnels, and on the plateau,
outh, shafts were sunk 50 to 70 feet before reaching bed-rock. South of Evans creek drift is strikingly
ntil, on descending into the valley of the Puyallup, we pass down over four terraces to the river, along
is a prominent feature. Leaving the Puyallup and crossing into the Mishall basin it disappears altogether
reappears as we descend into the upper valley of the Nisqually. Its presence and its absence are both
nt of the topography of the region during the ice period and bear upon the question of general glaciation
he Cascades.

ring on one side, as not pertinent to the present purpose, the historical relations of these various surface
the topography of the field has a very important connection with the economic value of its several b
; of these four are determined by topographical features, fixing the possible conditions of mining and
tation. The first may be designated the Wilkeson area, all that portion of the coal-field north and east
n river, including Carbonado and South Prairie; the second is the Evans Creek area, drained by Evans
ts creeks and extending from Carbon river to the flow, beneath which the Coal Measures disappear south of
reek; the third is the Puyallup area, that portion drained by the upper branches of the Puyallup proper;
h is the Nisqually area, including the Mishall basin and the Nisqually valley. The first and last are the
uable coal-fields and the easier of access. The Wilkeson area is already tapped by a branch of the Northern
which reaches its three mining points, South Prairie, Wilkeson, and Carbonado. The Evans creek area is
by streams, whose valleys cut it off from the adjacent coal-areas, yet afford no practicable approach for c
ransportation. Carbon river cañon forbids the extension of the railroad beyond Carbonado, and Voigts
th a fall of 2,200 feet in 13 miles, offers a route that is but little more satisfactory, even were the area as rich
oal-veins as that north of Carbon river, which is, however, not the case. The Puyallup area is similarly
of access, and its development as a mining region is like that of Evans creek, a doubtful question of an
e future. The southern end of the field includes the broad upper valley of the Nisqually, with a general
of 1,700 feet; a railroad line passing over the region of dry lakes at the head of Muck creek into this
lley was surveyed some years ago and proved practicable, and the existence of coal in the adjacent
s will sooner or later lead to its construction. The coal of the Mishall basin must be looked upon as a
for the future, to be mined from the Nisqually valley, the wild cañon of the Mishall being impracticable
road line and there being no other outlet to the area.

ctural geology.—The study of the geological structure of a much-disturbed series of sandstones, shales, d
veins, which presents no one well-defined horizon, and which is buried beneath a dense forest and heavy
s, is a matter of much difficulty. The general facts here given and the structure deduced from them are
t of three years' careful examination, during which over 700 coal-veins were discovered by digging down
the superficial deposits, and their relations traced by considering all the facts of dip, strike, detailed cross-
and horizontal and vertical position, as determined by accurate surveys.

he four topographical divisions of the coal-field, the Wilkeson and Evans creek areas are geologically one
onnection that may be definitely traced, and they are no doubt represented in the southern portion of the
hough the relation is difficult to establish.

principal feature of the northern district is an anticlinal axis extending from Voigts creek northward
Wilkeson to South Prairie creek, and beyond; its strike is a little west of north, its pitch sometimes north e
etimes south. Three miles south of Wilkeson this axis reaches its geological summit in the vicinity of the
y volcanic upheaval; here the lowest known coal-veins are exposed with the structure of a long crumpled
om this point the main axis pitches northward toward Wilkeson and southward toward Carbon river. A
ate anticlinal axis pitches toward the northeast, producing a trough between it and the main or Wilkeson
s trough may be called the eastern Wilkeson basin. A second or western basin lies between Wilkeson
onado; it is recognizable near Wilkeson, but lost farther south under the drift plateau.

onado itself is a region of great disturbance, well exposed in the cañon and developed in the mines, but
ed and not yet understood.

heastward from the geological summit of the main axis there is a small synclinal, apparently corresponding
eastern Wilkeson basin, but it fades away by a rapid southern pitch, and in the section measured on f
reek the dip is simple. Southwest from the same summit Carbon river exposes a section through several
ds, which pitch southward.

upon the study of this geological center and its radiating troughs and arches that the Wilkeson columnar
based.

section measured on Voigts creek consists of 10,260 feet of strata, containing little coal but a great number
beds, which are recognized on upper Fletts creek, east of the lowest beds exposed, and may be called the
ny measures. The interposition of the Wilkeson series, as measured on either side of the Wilkeson axis by
ection and diamond-drill, between this bony series and the lower beds, rests on the comparative pitch of the
s and the character of the coal-beds. The position of the beds worked at Carbonado is very difficult to
e and they cannot be placed with any certainty, but I am inclined to believe they lie between the Wilkeson

a and the lowest known beds. The column thus constructed consists of 3,000 feet of productive measures under 10,000 feet of comparatively barren measures. Where the proportion of valuable property to worthless moun is so small, the importance of knowing the geology before investing is apparent.

Aside from this, the geological structure has a most important bearing on the development of the mines. at Carbonado the Coal Measures are crumpled into four or more anticlinal folds, with narrow intermediate tro cut by faults at an angle to the axes, which pitch northward. Carbon river exposes these folds in a cañon abou feet deep, having a crooked, northwest course. South of the coal-mines, and within 200 yards of the southern openings, the river-channel is cut down into the volcanic rock of the secondary upheaval. Of a number of gang started southward from the river, all but two have been abandoned, and these two, being the farthest wes farthest removed from the intrusive rock; they may continue to be profitably worked for some time. The gr b north of the river has been developed by gangways run in on the veins from the river, and by a rock tunnel started near the western edge of the original property and runs eastward. This tunnel crosses the same succe of faulted anticlinals cut by the cañon. Gangways driven southward from it would open upon the cañon, i interrupted by faults; gangways driven northward from it encounter the descending anticlinals in a comparat short distance, and in one case at least a gangway has been driven on the vein around the axis, returning t cross-cut tunnel. This tunnel is, however, progressing eastward toward the western basin, which lies bet Wilkeson and Carbonado, and is penetrating into lower beds. Were good mining surveys and facts determi by surface prospecting accessible, the extent of this basin and the ultimate value of this tunnel might be estim Had the facts of the geology been understood before the mines were begun, a different plan, involving less o c and securing more profitable results would probably have been adopted.

The difficulty of mining on a descending pitch, which results in a lift that decreases in each vein from a max to nothing between the beginning of a gangway and its intersection with the axis, and in a proportionately amount of rock work, is not to be encountered at Wilkeson.

Where Fletts creek passes from its narrow gorge into the little valley up which the railroad has been b short section of the measures, containing three coal-veins on a western dip of 80° to 90°, is exposed. These beds are also known on the eastern dip of 53° on the other side of the northward-pitching main axis. A di volcanic rock, which forms low cliffs on Fletts creek, near the top of the arch and on the eastern side, is the surface evidence of disturbed measures, proved by small faults in the gangways on both sides of it, and expens explored by a large slope, sunk 300 feet, on the western dip. The southern extension of the three beds had, how d been early proved—on the eastern dip for 2½ miles, on the western for 1½ mile—and the existence of under over-lying beds has since been determined. Gangways driven on these veins with an increasing lift will ultim concentrate at Wilkeson the coal of the eastern and part of the western basin, and render the product of the series accessible by cross-cut tunnels.

The structure of the southern portion of the field, so far as it is known, is sufficiently indicated i accompanying sections of the Mishall basin (Plate LXXXIX), as measured near the Narrowgauge and on brook. The region west of Vista peak is evidently one of great disturbance and of very extensive faulting Busy brook these faults, though of less extent, are apparent in the presence of dikes, some of which have a the coal of adjacent veins to coke.

The examination of this remote part of the field, only accessible after the construction of a mountain trai e a pass of 4,000 feet elevation, was interrupted before the extension of good veins into the Nisqually valley had determined. Upon a satisfactory answer to this uncertainty rests the probable value of the Nisqually area.

Character of the coal.—As stated in the general discussion of the Washington Territory coals, the Wil field produces black, highly bituminous, coking coal, unlike any other known on the Pacific coast south of A Its chemical qualities are sufficiently shown in the many analyses which accompany this report; and the se of the beds indicate their structure. The analyses are of full cross-section samples, taken to show the qual coal which could be shipped on a commercial scale. It should be said, however, that these analyses show a ash percentage than has been hitherto obtained in mining. The coal throughout the field is soft and makes fine coal. If carefully mined, screened, and hand-picked, good clean lump-coal can be produced, the subse crushing of which, in transportation, will not affect its value for many purposes. The finer screenings can a f cleaned and utilized, since the coking character of the coal makes even the finest material available, when It has, however, been the custom at Carbonado, as well as in the small shipments from Wilkeson, to ship unscr coal as it comes from the mine, except for the removal of large pieces of bone by hand-picking of coarse an coal mixed. The reputation of the mines is, therefore, not a good one in the Pacific Coast markets; but it is, f same reason, capable of great improvement.

I would, in this connection, call attention to the analyses of coke given on Plate XCII, with the detailed se of the beds from which the coke was made. The analyses represent average samples of about a ton of coke each bed; the very low percentage of ash, as compared with that of the corresponding coal samples, is due: the partial removal of thin layers of bone from the purer coal, by the weathering of the coal, which was mi short prospect tunnels in December, and lay exposed to snow and rain till April, when it was burned in hea

DEPARTMENT OF THE INTERIOR.

GEOLOGICAL SECTION OF THE MISHALL BA

SHOWING THE FAULTED

Sca

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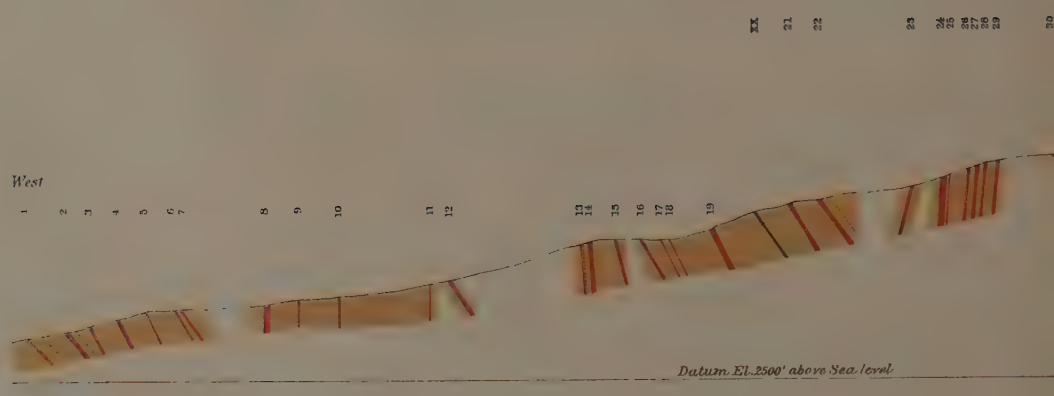
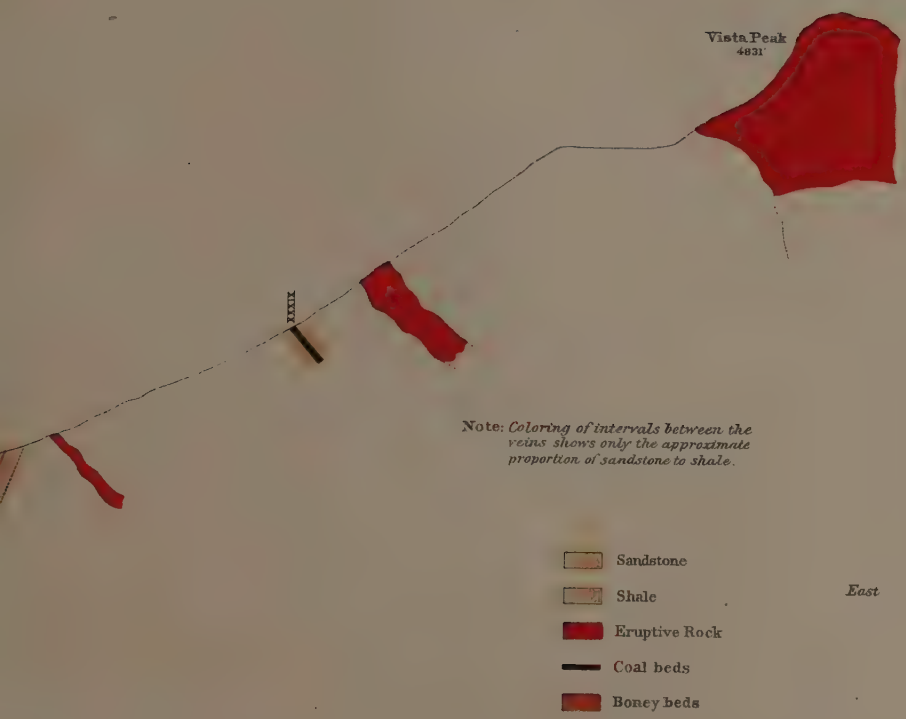
Geology b



From unpublished M.S. material of the Northern Transcontinental Survey.

ELD NEAR THE NARROWGAUGE.
A PEAK.



Julius Bien & Co Lith.

OUTLINE MAP OF

GREEN RIVER AND THE ADJACENT COALFIELD

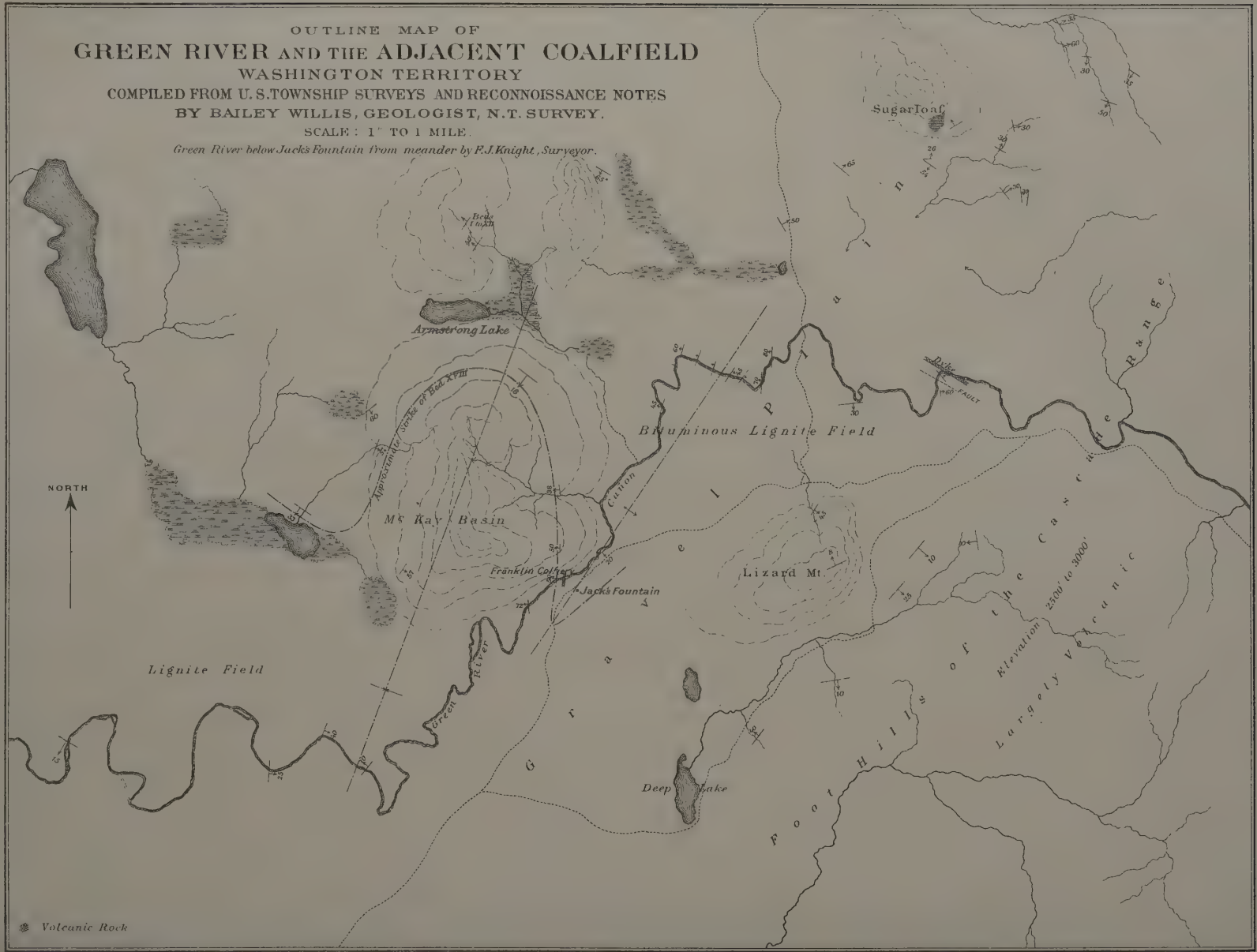
WASHINGTON TERRITORY

COMPILED FROM U. S. TOWNSHIP SURVEYS AND RECONNOISSANCE NOTES

BY BAILEY WILLIS, GEOLOGIST, N.T. SURVEY.

SCALE: 1" TO 1 MILE.

Green River below Jacks Fountain from meander by F. J. Knight, Surveyor.



From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

WIL

GEOLOGICAL SECTION

IN THE EVANS CREEK AREA, FROM THE MAIN A

the ground. (2) To the fact that the bone associated with the coal does not produce marketable coke, and was, a therefore, rejected as not a legitimate part of the merchantable product. The proportion of coke obtainable from any coal-bed of the Wilkeson field depends directly upon the amount of ash the market will buy. By careful mining and subsequent treatment of the coal very excellent coke can be produced.

THE GREEN RIVER COAL-FIELD.

Position and boundaries.—The Green River coal-field takes its name from the clear mountain stream which cuts a deep east and west section into the Coal Measures 30 miles northeast of Tacoma, and about the same distance southeast of Seattle. This exposure is the first appearance of sedimentary rocks north of Wilkeson. A few low b hills near Green river, within what may be called the coal-field, several pinnacles of volcanic rock near White river, and the lignite outcrops on Cedar river are the only breaks in the great drift plain traversed by the streams which flow into Elliot bay.

As may be inferred, the limits of the coal-field on the northwest and south are simply the disappearance of the strata under the all-obscuring gravel sheet. The eastern border is a much more definite contact with the bold outliers of the Cascade range, composed of volcanic breccia.

The area of so indefinite a coal-field can only be stated approximately at 50 square miles, of which but a small part is likely to be profitably productive.

Topography.—The low round hills and terraces of the Green River field are in strong contrast to the mountainous character of the Wilkeson region. Green river issues from its narrow gorge in the western slope of the Cascades, c up which the proposed line of the Northern Pacific railroad is located, into the nearly level drift plain, at an elevation of about 900 feet. Flowing for 2 miles between low banks, it descends into the cañon which it has cut, 200 feet below the general surface of the adjacent plain. Now it dashes in little rapids through the narrow gateways, formed by massive sandstone strata highly inclined, now it eddies in the intervening pools, where soft shales and coal-beds allow it to widen its bed. On the southeast of this cañon the spurs of the Cascades sweep round toward the west in a quarter circle, mount Enem Claugh rising abruptly in a bold cliff from the rolling drift surface. Between these volcanic foot-hills and the river is an isolated hill, several hundred feet high, called Lizard mountain. It consists of nearly horizontal Coal Measures severed by erosion from the steeply-dipping strata on the north. Northward the terraced plain stretches to the Swak range beyond Cedar river, and to the southwest it reaches, without interruption, across White river. But on the west, north of Green River cañon, and about 6 d miles from its eastern boundary, the level is broken by a group of low hills, which cover an area of 3 or 4 square miles, the most valuable portion of the coal-field, the McKay basin.

Geology.—Geologic study of the Green River field has been confined to the notes of Professor E. W. Hilgard, to my occasional observations, beginning in the autumn of 1881, and to the survey by Mr. F. J. Knight of the cañon west of Jack's Fountain. With the aid of topographic surveys of the northwest part of the field, made by the Transcontinental Survey, and Mr. Knight's work, it is possible to construct the columnar section of the Coal Measures of the McKay basin (Plate LXXXI); but all the eastern and southeastern area remains known only through reconnaissance work.

Viewed broadly the Green River coal-field may be looked upon as a flexed and correspondingly metamorphosed corner of the extensive lignite field, into which it passes on the west and north. Inasmuch as those qualities e which give the coal a greater value than lignite are dependent on the degree of this flexure, the worth of lands beyond its visible boundaries is doubtful, and a hint of the limits thus set to the valuable coal area is to be found in the presence of lignites a mile west of the Franklin colliery and on Cedar river.

Looked at in detail the bituminous-lignite area varies considerably in the steepness of dips. The broad synclinal of the McKay basin, so well developed by six openings on bed XVIII G. R. is succeeded on the east by much sharper folds, and in the extreme northeast, close to the foot-hills of the Cascades, there is evidence of much faulting. In the southeastern portion of the field, on the contrary, is a flat anticlinal, which exposes in Lizard mountain and vicinity beds that probably lie below the lowest known in the McKay basin. If this view be correct, the outcrop of bed XVIII G. R. trends back southward in an irregular curve under the gravel plain around Deep lake, and the workable series, of which it is the principal vein, is not to be found in the eastern half of the field. f

While the data at hand do not justify further general conclusions, there are certain details worthy of note. The section of the McKay basin gives a continuous column of 5,300 feet, and I have placed below it a series of twelve beds observed near Armstrong lake. On Green river, where it makes its northern cut across the anticlinal that bounds the McKay basin on the east, a number of large bony beds are exposed with dips of 45° to 80°; these beds very probably lie between XII and 13 of the columnar section.

In Lizard mountain, presumably below No. 1 of the column, is a bed of carbonaceous shale with many earthy partings, which aggregates 125 feet in thickness and contains 15 feet of fair coal in two benches. There are also several workable beds in the vicinity of the Sugarloaf, but while their dips indicate one or several extensive faults, the facts are not definite enough to determine their relations.

a The eruptive rocks of this field form the great mass of volcanic breccia of which the adjacent foot-hills are composed, and occur as dikes in the sedimentary strata. One of the latter, exposed by the river, is the apparent cause of a fault of 30 feet horizontal throw near by, and penetrates the slate in the curious ramifications of the accompanying section on Plate LXXXIII.

Another dike (or flow?) 70 feet thick occurs in the McKay basin, between beds XIV and XV. It is exactly conformable to the sedimentary beds, and when traced south to the anticlinal it appears to follow the strike around the axis and forms the core of a ridge above Jack's Fountain, the trend of which coincides with the strike of the southern dip. That an intrusive dike should thus conform to the folds of the strata is very improbable, and the evidence of this single instance is therefore in favor of volcanic activity during the formation of the coal series.

b An interesting occurrence is that of veins of realgar and orpiment, associated with quartz, in the black slates that form the cliff of Realgar point, on Green river.

Character of the coal.—The bituminous lignite of Green river is a hard, brilliant coal, of moderate heating power. It differs essentially from the Wilkeson coal in that it is harder and does not make a serviceable coke. It will find a ready market in all cases where the demand for cleanliness and cheerfulness overrules the economy of the greater heating power of the more highly bituminous coals.

DETAILED CROSS-SECTIONS OF THE COAL-BEDS OF THE WILKESON AND GREEN RIVER COAL-FIELDS, WASHINGTON TERRITORY.(*a*)

c

[Arranged in order of position in the columnar sections, beginning at the bottom of each column.]

The general course of the geologic axes is north and south, and the sections are all drawn looking north on the dip observed in each individual case in the field. The least thickness defined in the sections is one inch. Each analysis belongs to the bed immediately above it.

In the absence of all other data for determining the relative horizons of different parts of the same coal-field the identification of coal-beds became a most important problem in developing the structural geology; and this identification, restricted always to small areas, depended necessarily on the cross-sections of the beds in different test-pits. While no definite rules can be laid down for such comparisons, the following factors have been considered in the order here given:

(1) The presence of one or several well-defined benches of coal, considered characteristic in proportion to d thickness and purity; thus the 5-foot bench of pure coal in vein V W. C. (Plate XCII), identifies it in the third and fourth sections given although the mixed upper benches have passed into brown shale.

(2) The presence of a strong parting of pure sandstone or shale, associated with similar benches of coal; thus vein XVIII W. C. is identified by the sandstone parting near the top with its adjacent beds of good coal, although the lower part of the bed varies between brown slate and inferior coal.

(3) The probability of transition of a bed of inferior coal into one of bone, and of bone into carbonaceous shale.

(4) The tendency of conditions governing the purity or impurity of a sediment to be constant for a considerable period for any one locality, so that if a bed of inferior coal in one opening corresponds to a bed of bone in another, a bony bench in the first will probably be represented by a layer of shale in the second; this is illustrated in the sections of vein VI W. C., Plate XCII. The third section of that bed represents a locality where the sediments were e heavier and more earthy during its entire formation than over adjacent areas of contemporaneous deposition; the identity of the bed would be lost but for its relation to others.

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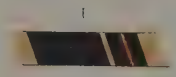
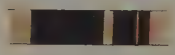
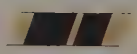
a Definition of terms.—Coal: Lignitic or bituminous material, recognized when hard by the ordinary characteristics of lignite or bituminous coal; when decomposed, at the outcrop, by the shape of minute particles, with or without luster, by not cohering when pressed in the hand, and by rough ash determination; ash not to exceed 25 per cent., and qualified as inferior or bony coal where it is above 18 per cent. Bone: Material ranging from inferior coal to black slate; recognized when not weathered by its hardness, lamination, and earthy streak; when softened, by cohering when pressed, and by the flatness of small pieces. Slate: Argillaceous beds; light-gray (and often slightly arenaceous) to dark-brown carbonaceous shales.

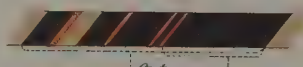


	Coal	Coke
M.	1.54	1.07
V.C.	28.17	2.73
C.	59.70	86.21
Ash	10.59	9.99
	100.00	100.00



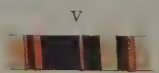
			Coke
M.	1.03	1.17	1.23
V.C.	26.36	27.32	3.10
C.	49.69	56.36	86.14
Ash	22.92	15.15	9.53
	100.00	100.00	100.00

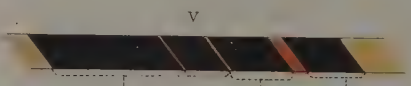




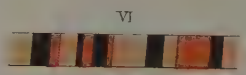
	Outcrop	
M	3.56	2.86
V.C	29.01	30.86
C.	52.26	58.25
Ash.	15.17	8.03
	100.00	100.00

	Tunnel		Coke
M.	1.77	1.16	2.14
V.C.	26.16	29.09	5.52
C.	50.99	60.38	84.49
Ash.	21.08	9.37	7.85
	100.00	100.00	100.00





0.00	0.45	0.41
28.91	27.62	28.70
56.16	52.04	52.70
14.93	19.89	18.19
100.00	100.00	100.00



7, 8, 9 and 10 = Beds of Bone, respectively 3'9", 1' and 2'7" thick cut by diamond drill only

Scale 10 feet to 1 inch.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

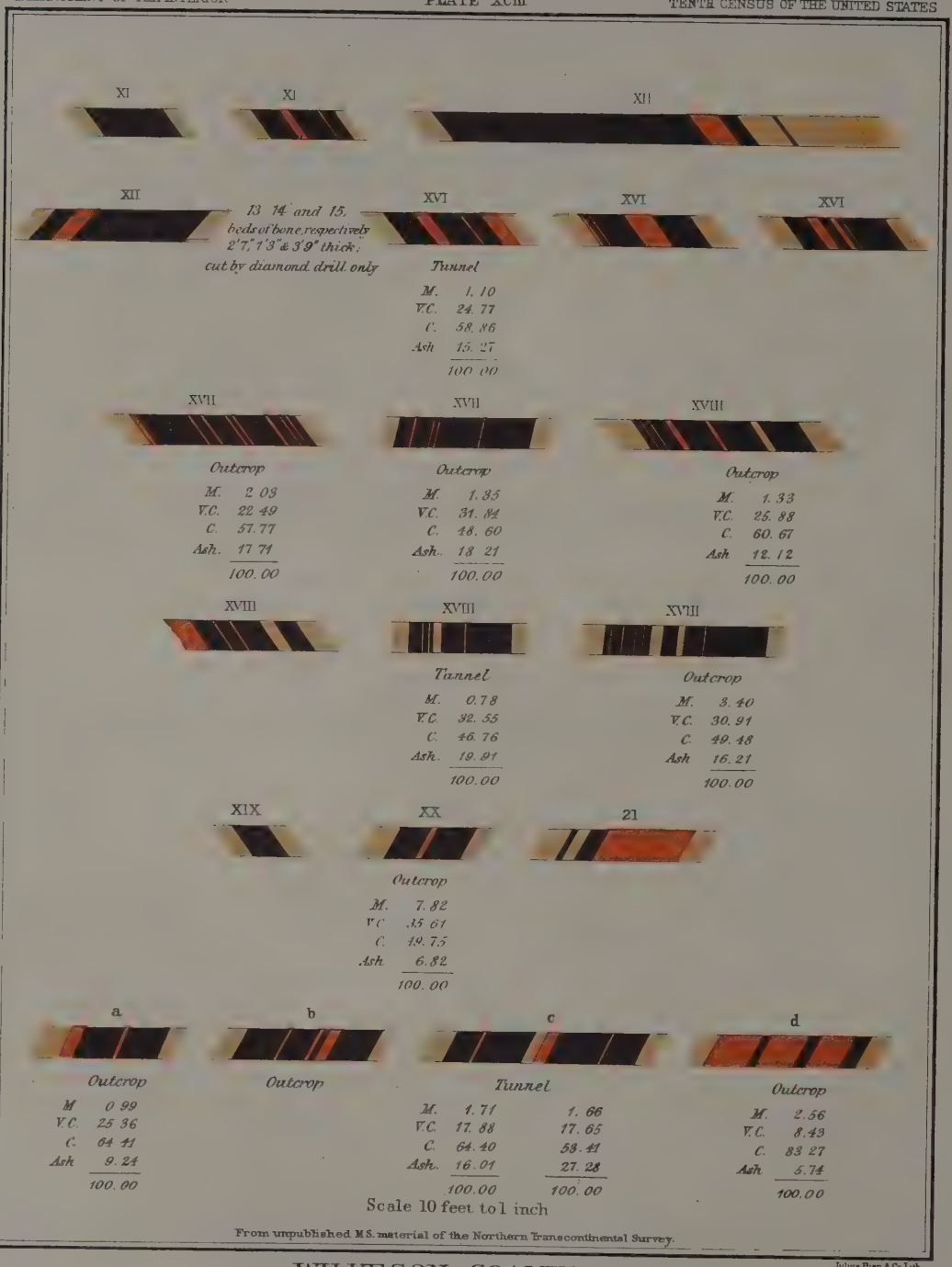
WILKESON COALFIELD

BEDS OF THE LOWER SERIES W. C

W.C = Wilkeson. Column

Coal — Bone — Slate — Sandstone

Observed and sampled by Bailey Willis, Geologist



From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co Lith.

WILKESON COALFIELD

BEDS OF THE WILKESON SERIES W. C.

W.C.- Wilkeson Column

Coal | Bone | Slate | Sandstone

Observed and sampled by Bailey Willis, Geologist.

Scale 10 feet to 1 inch

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

WILKESON COALFIELD

BEDS OF THE EVANS CREEK SERIES W. C

W.C.- Wilkeson Column

Coal | Bone | Slate | Sandstone

Observed and sampled by Bailey Willis, Geologist

Scale 10 feet to 1 inch.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

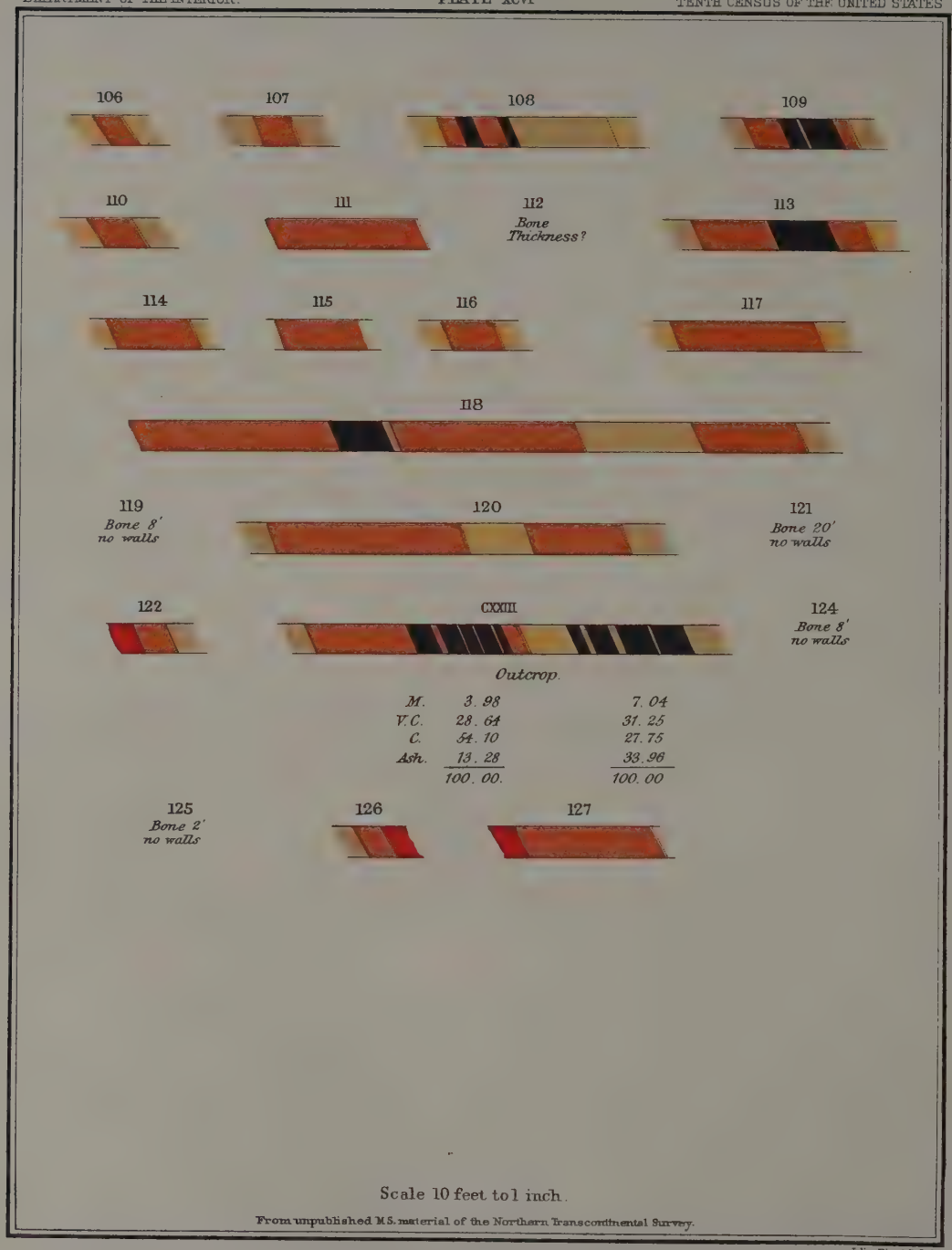
WILKESON COALFIELD

BEDS OF THE EVANS CREEK SERIES W. C.

W.C.- Wilkeson Column

Coal — Bone — Slate — Sandstone

Observed and sampled by Bailey Willis, Geologist



Scale 10 feet to 1 inch.

From unpublished M.S. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

WILKESON COALFIELD

BEDS OF THE EVANS CREEK SERIES W. C

W.C.- Wilkeson Column

Coal | Bone | Slate | Sandstone | Volcanic rock

Observed and sampled by Bailey Willis, Geologist

Julius Bien & Co. Lith.

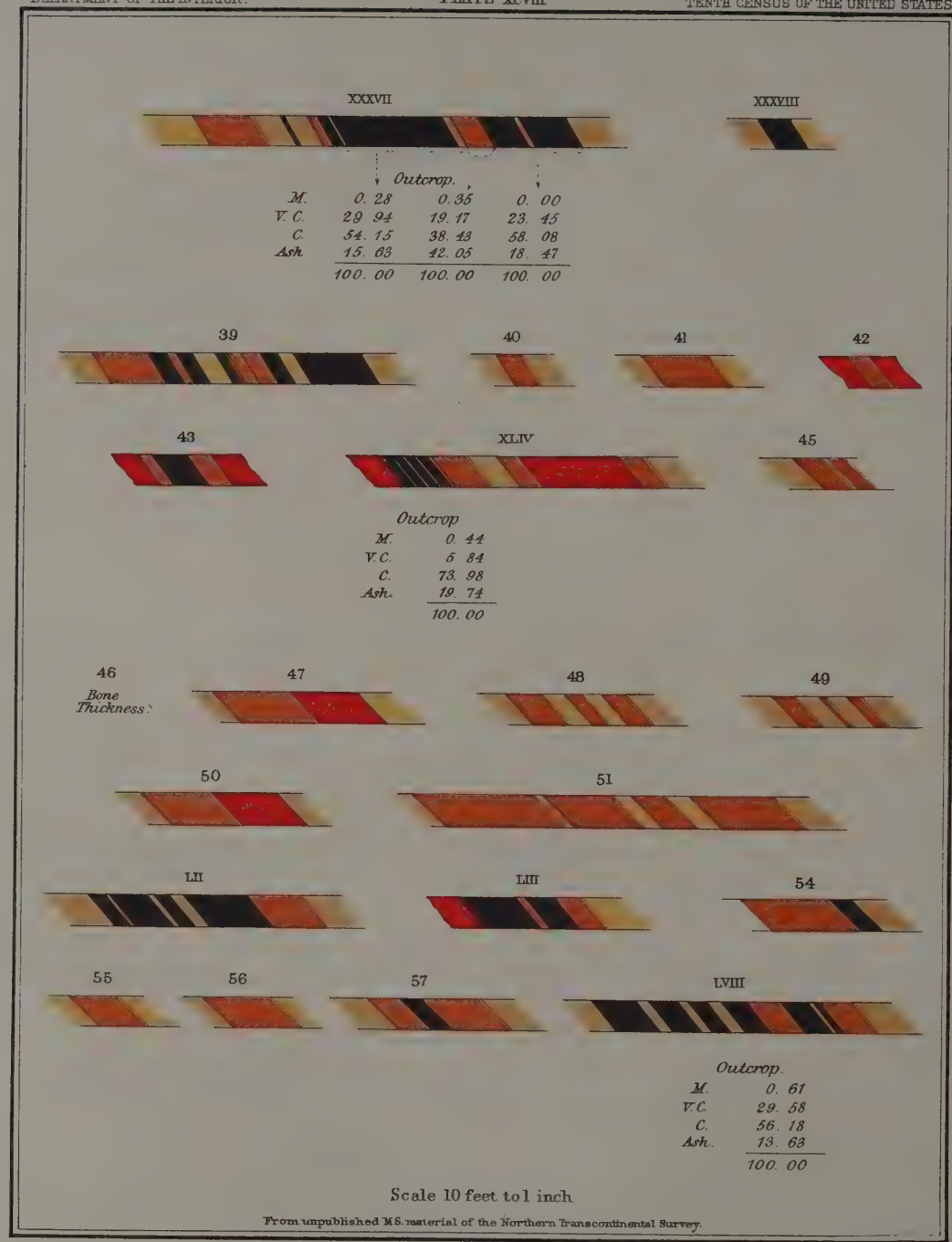
WILKESON COALFIELD

BEDS OF THE BUSY BROOK SECTION B.B.C.

B.B.C. Busy Brook Column

Coal | Bone | Slate | Sandstone | Volcanic rock

Observed and sampled by Bailey Willis, Geologist



Julius Bien & Co. Lith.

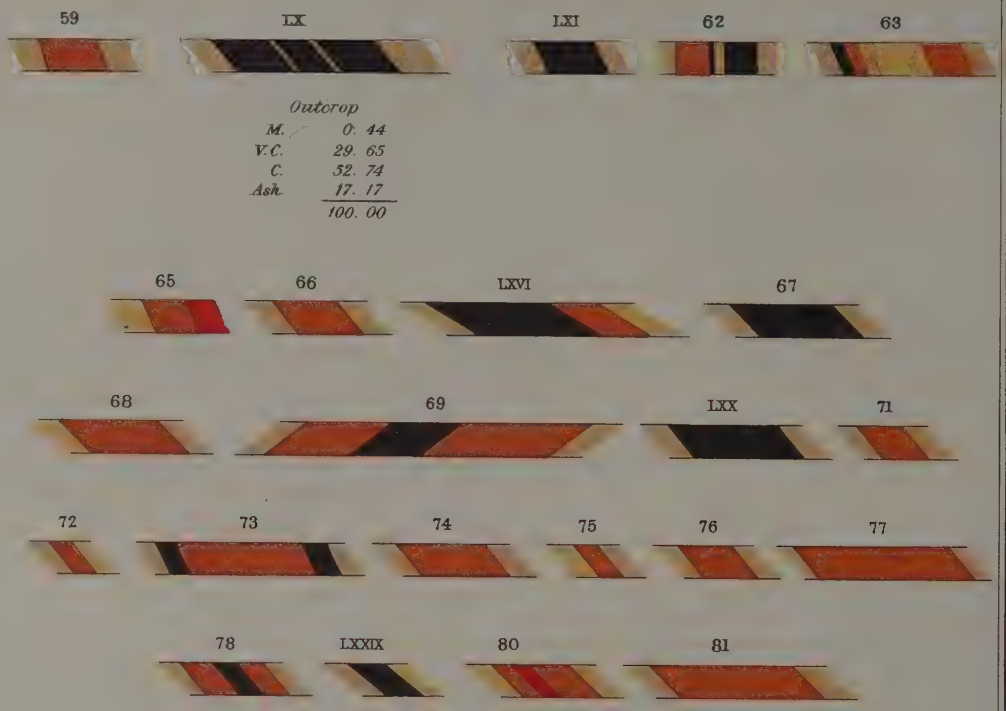
WILKESON COALFIELD

BEDS OF THE BUSY BROOK SECTION B.B.C.

B.B.C.= Busy Brook Column

Coal | Bone | Slate | Sandstone | Volcanic rock

Observed and sampled by Bailey Willis, Geologist



Scale 10 feet to 1 inch.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

WILKESON COALFIELD

BEDS OF THE BUSY BROOK SECTION B.B.C.

B.B.C.- Busy Brook Column

Coal | Bone | Slate | Sandstone | Volcanic rock

Observed and sampled by Bailey Willis, Geologist

Scale 10 feet to 1 inch.

From unpublished MS. material of the Northern Transcontinental Survey.

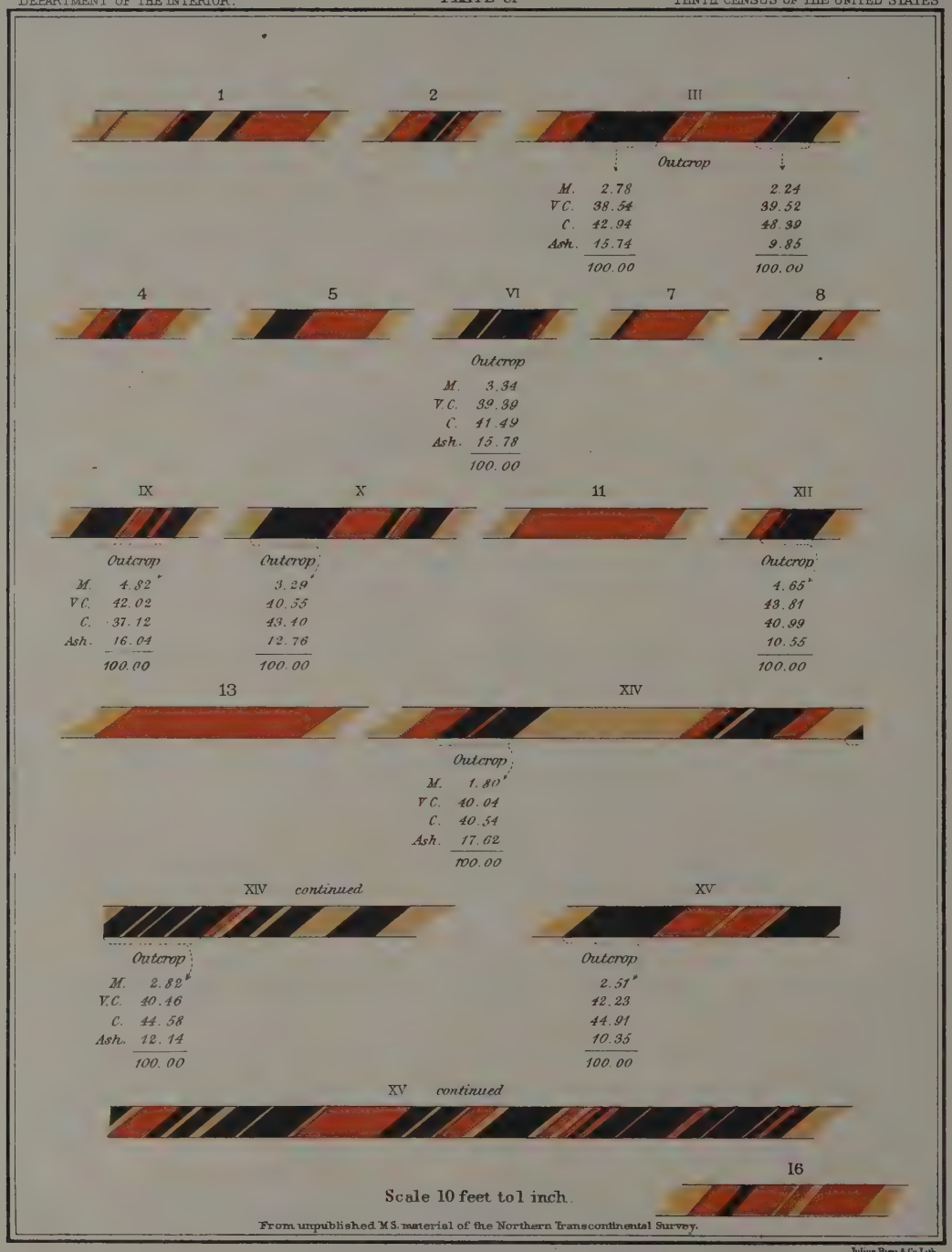
Julius Bien & Co. Lith.

WILKESON COALFIELD

BEDS OF THE NARROWGAUGE SECTION

Coal Bone Slate Sandstone

Observed and sampled by Bailey Willis, Geologist



From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co. Lith.

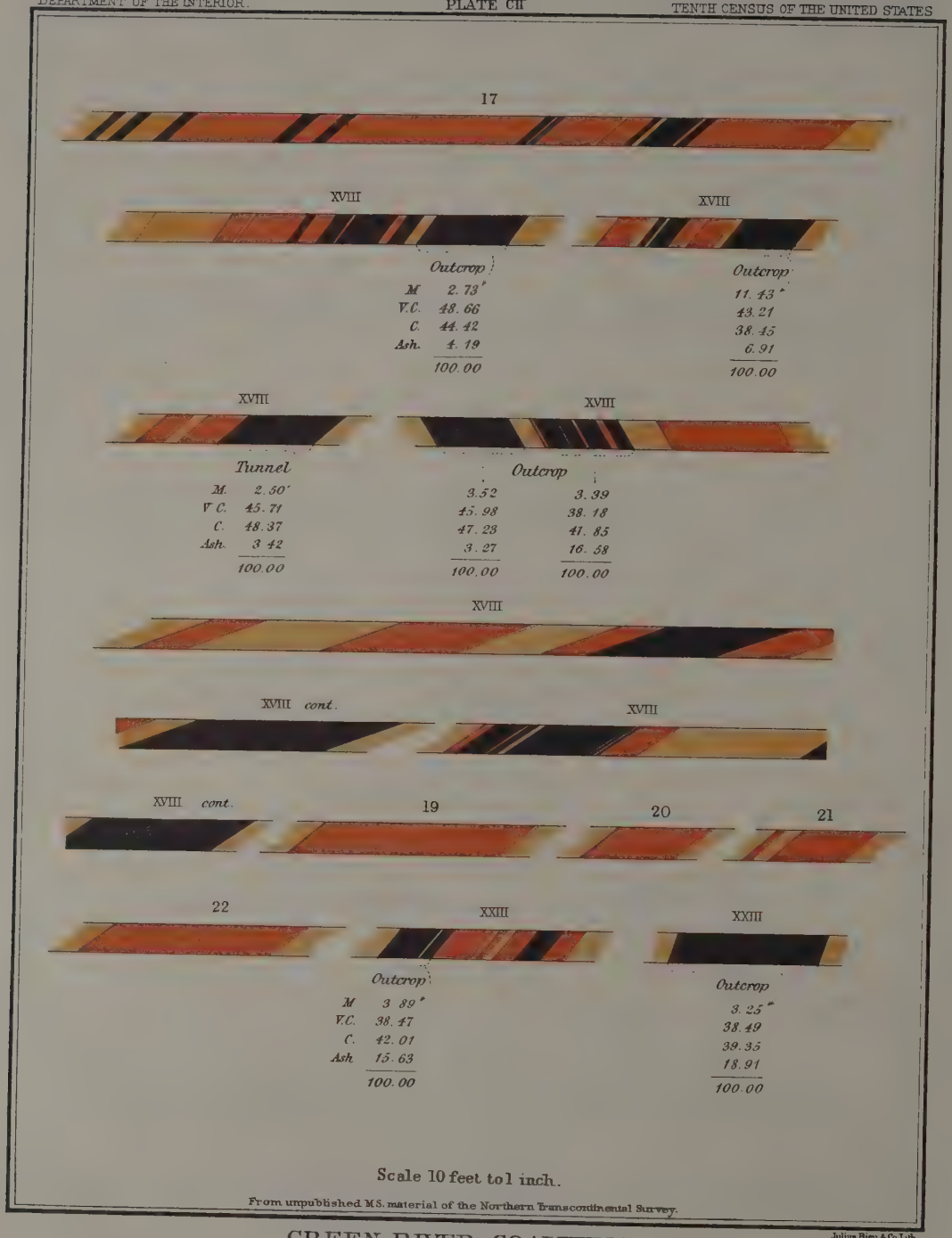
GREEN RIVER COALFIELD

BEDS OF THE McKAY BASIN G C

G.C - Green River Column

Coal Bone Slate Sandstone

Observed and sampled by Bailey Willis, Geologist



Scale 10 feet to 1 inch.

From unpublished MS. material of the Northern Transcontinental Survey.

Julius Bien & Co Lith.

GREEN RIVER COALFIELD

BEDS OF THE McKAY BASIN G.C.

G.C. - Green River Column.

Coal | Bone | Slate | Sandstone

Observed and sampled by Bailey Willis, Geologist

TABLE 46.—*Analyses of commercial samples from the coal fields of Washington territory. Samples taken by Bailey Willis.*

[Columnar numbers W., G., and B. B. refer respectively to the Wilkeson, Green River, and Busy Brook sections, accompanying the report.]

ANALYSIS.						COAL-BED.			
Number.	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Coke.	Thickness represented.	Columnar number.	Name or field number.	Locality.
						Ft. In.			
1	1.79	32.89	46.23	19.09	Good	2 6			Nos. 1 to 10 are from beds cut in the first 1,600 feet of the North Rock tunnel, Carbonado.
2	1.97	29.45	42.36	26.22	Fair	3 0			
3	1.78	27.63	51.66	18.93	Poor	7 0			
4	2.56	26.49	30.34	40.61	do	5 0			
5	2.22	33.51	44.91	19.36	Fair	3 6			
6	1.55	32.37	45.43	20.75	Good	3 7			
7	2.10	29.42	36.21	32.27	do	4 6			
8	2.28	32.39	42.89	22.44	do	4 6			
9	2.41	32.06	46.64	18.89	do	4 10			
10	2.85	28.50	36.26	32.39	Fair	5 2			
11	1.69	41.00	48.96	8.35	Good	4 6		Miller	Carbonado mines.
12	1.80	42.27	52.11	3.82	Very good	4 8		Wingate	Do.
13	1.41	33.05	46.63	18.91	Good	8 6			Do.
14	1.27	36.22	57.11	5.40	do	3 0			Do.
15	4.27	36.24	52.40	7.09	Poor	13 0			Do.
16	6.80	35.10	52.14	5.96	do	7 0			Do.
17	1.33	25.88	60.67	12.12	Excellent	6 8	XVIII W.	Smith vein	Fletts creek, near Wilkeson.
18	1.30	27.29	54.01	17.40	do	8 0	XVII W.	Goodwin	Do.
19	1.10	24.77	58.86	15.27	do	5 4	XVI W.	Gale	Do.
20	1.22	32.88	50.67	15.23	do	7 2	XVII W.	Ainsworth	Old tunnel at Wilkeson.
21	0.78	32.55	46.76	19.91	Good	6 0	XVIII W.	Wright	Do.
22	2.03	22.49	57.77	17.71	Excellent	8 0	XVII W.	Goodwin	Outcrop 2½ miles from Wilkeson.
23	4.13	42.97	43.36	9.54	Non-coking	9 8		No. 2 vein	Newcastle lignite.
24	4.16	44.84	43.86	7.14	do	9 10		do	Do.
25	6.59	44.71	41.30	7.40	do	10 5		do	Do.
26	4.18	43.79	40.20	11.83	do	7 6		Bagley	Do.
27	2.50	45.71	48.37	3.42	Poor	4 0	XVIII G.	Empire tunnel	McKay basin, Green river.
28	1.80	40.04	40.54	17.62	do	2 10	XIV G.		Do.
29	2.82	40.46	44.58	12.14	Worthless	4 2	XIV G.		Do.
30	2.51	42.23	44.91	10.35	Poor	3 6	XV G.		Do.
31	3.89	38.47	42.01	15.63	Non-coking	2 8	XXIII G.		Do.
32	1.03	26.36	49.69	22.92	Worthless	5 3	II W.	G bed	Three miles south of Wilkeson.
33	3.56	29.01	52.26	15.17	do	8 0	V W.	P bed	Do.
34									Part of sample 33.
35	2.86	30.86	58.25	8.03	Poor	4 9	V W.	P bed	Three miles south of Wilkeson.
36	1.17	27.32	56.36	15.15	Fair	3 5	II W.	G bed	Do.
37	1.54	28.17	59.70	10.59	Poor	6 4	I W.	H bed	Do.
38	2.43	36.33	45.14	16.10	Non-coking	6 4		Mammoth	Lizard mountain, Green river.
39	4.63	35.51	42.79	17.07	do	9 7		do	Do.
40	4.65	43.81	40.99	10.55	do	2 5	XII G.		Northern field, Green river.
41	3.29	40.55	43.40	12.76	Sinter	4 0	X G.		Do.
42	4.82	42.02	37.12	16.04	None	4 11	IX G.		Do.
43	3.34	39.39	41.49	15.78	do	5 3	VI G.		Do.
44	2.78	38.54	42.94	15.74	do	4 3	III G.		Do.
45	2.24	39.52	48.39	9.85	do	2 8	III G.		Do.
46	11.43	43.21	38.45	6.91	do	3 8	XVIII G.	McKay bed	McKay basin, Green river.
47	2.73	45.66	44.42	4.19	Rather poor	5 0	XVIII G.	do	Do.
48	3.25	38.49	39.35	18.91	Sinter	9 7	XXIII G.		Do.
49	1.84	42.45	45.90	9.81	Poor	4 4	XV G.		Do.
59	8.68	35.90	47.07	8.35	None	2 6			Lignite, Lower Green river.
51	7.46	37.14	32.20	23.20	do	4 5	40 G.		Do.
a52							(?)		Do.
a53							(?)		Do.
a54							35 G.		Do.
55	9.35	40.77	47.25	2.63	None	7 0	34 G.		Do.
56	9.98	40.63	41.07	8.32	do	5 0	33 G.		Do.
57	8.09	36.48	33.11	22.32	do	8 0	38 G.		Do.
a58							(?)		Do.
59	7.27	36.02	28.48	28.23	None	15 3	(?)		Do.

a Not analyzed.

TABLE 46.—*Analyses of commercial samples from the coal-fields of Washington territory*—Continued.

ANALYSIS.						COAL-BED.			
Number.	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Coke.	Thickness represented.	Columnar number.	Name or field number.	Locality.
						Ft. In.			
60	1.35	31.84	48.60	18.21	Very good	9 0	XVIII W.	Kelly	One and a half miles south of Wilkeson.
61	1.19	32.06	48.14	18.61	do	9 0	XVIII W.	do	Do.
62	2.11	32.15	50.03	15.71	Poor	6 0		Henry, top	Near Carbonado.
63	2.24	32.77	52.56	12.43	do	7 0		Henry, bottom	Do.
64	1.16	29.09	60.38	9.37	Excellent	5 1	V W.	P. bottom bench	Three miles south of Wilkeson.
65	1.77	26.16	50.99	21.08	Dense	3 2	V W.	P. top bench	Do.
*b*66									
67	2.14	5.52	84.49	7.85		8 3	V W.	P. (coke)	Do.
68	2.56	8.43	83.27	5.74	Non-coking	2 0	d W.	d	Carbon river, Wilkeson.
69	0.99	25.36	64.41	9.24	Excellent	5 0	a W.	a	Do.
70	1.71	17.88	64.40	16.01	Non-coking	4 6	c W.	c. top bench	Do.
71	1.66	17.65	53.41	27.28	do	5 2	c W.	c. bottom bench	Do.
72	1.07	2.73	86.21	9.99		6 4	I W.	H. (coke)	Three miles south of Wilkeson.
73	1.23	3.10	86.14	9.53		5 3	II W.	G. (coke)	Do.
74	7.82	35.61	49.75	6.82	Non-coking	3 8	XX W.	Coggeshall	One and a half miles south of Wilkeson.
75	3.40	30.91	49.48	16.21	do	6 0	XVII W.	General	Do.
76	1.17	14.40	64.56	19.87	Poor	3 5		Connor	Skagit river, Washington territory.
*b*77									Do.
*b*78									Do.
79	14.10	36.95	35.76	13.19	Non-coking	4 9			Miles City, Montana.
80	3.00	26.99	46.85	23.16	Poor	7 5			Northwest part of Green River field.
81	12.12	33.25	46.28	8.35	None	3 10		Scenery vein, top	Do.
82	15.68	31.28	41.87	11.17	do	8 2		Scenery vein, bottom	Do.
83	2.78	22.39	33.93	40.90	do	3 9			Northern part of Green River field.
84	6.03	25.84	51.32	16.81	do	4 0	XVI W.	Gale	Near Wilkeson.
85	3.87	25.67	60.18	10.28	Poor	5 10	XVIII W.	Smith	Do.
86	1.08	24.40	34.71	39.81	do	1 6			Blue mountains, Oregon.
87						6 8			Carbon river, Wilkeson.
88	3.39	38.18	41.85	16.58	Poor	4 3	XVIII G.	Top bench	McKay basin, Green river.
89	3.52	45.98	47.23	3.27	do	5 0	XVIII G.	Bottom bench	Do.
90	1.40	21.17	43.32	34.11	Fair	1 2	XVIII W.	Smith	Samples 90 to 93 were taken by diamond-drill near Wilkeson, and contain much foreign sand.
91	1.46	18.73	35.70	44.11	do	5 0	XVIII W.	do	
92	1.36	20.80	41.06	36.78	Good	7 7	XVII W.	Goodwin	
93	1.13	14.28	21.66	62.93	Poor	7 0	XVI W.	Gale	
94	0.54	59.61	31.45	8.40	None				Float-coal from Kootenay river.
95	3.00	37.96	57.49	1.55					Picked coal from Admiralty island, Alaska.
96	0.80	18.14	40.49	40.57	None	2 6	XII W.	Black	Samples 96 to 99, inclusive, were taken by diamond-drill near Wilkeson, and contain much foreign sand.
97	0.63	22.31	56.16	20.90		7 7	XII W.	do	
98	0.90	19.72	45.80	33.58		3 1	XII W.	do	
99	1.35	18.07	37.78	42.80		4 1	XI W.	Stark	
100	0.86	9.80	50.93	38.41	None	5 3		120. Scotchman	Evans creek, Wilkeson field.
101	2.24	9.45	57.16	31.15	do	4 6		120. Scotchman	Do.
102	0.85	12.67	69.22	17.26	do				Several beds of Puyallup area, Wilkeson field.
103	0.37	17.25	45.01	37.37	do	4 2		488	Evans creek, Wilkeson field.
104	0.53	15.47	24.60	59.40	Poor	(?)			Do.
105	0.33	14.95	31.85	52.87		(?)			Do.
106									Limestone from Alaska.
107									Limestone from Skagit river.
108									Limestone from Baker river.
109	1.53	42.82	44.94	10.71	Poor	3 0			Camas mountain, southern Oregon.
110	1.06	24.41	47.19	27.34	Good	6 1		303. Nisqually Chief, top	Mishall basin, Wilkeson.
111	1.24	22.65	47.93	28.18	do	6 8		303. Nisqually Chief, middle.	Do.
112	1.04	24.12	51.46	23.38	do	7 3		303. Nisqually Chief, bottom.	Do.
113	0.88	26.09	64.54	8.49	do				Picked coal from Mishall basin, Wilkeson.
114	1.60	14.04	54.60	29.76	None	7 9		354	Mishall basin, Wilkeson.
115	0.91	26.78	47.67	24.64	Good	6 0		352	Do.
116	0.68	25.17	54.78	19.37	do	4 6		341	Do.
117	0.83	22.35	42.79	34.03	do	2 9		341	Do.
118	0.69	24.93	56.91	17.47	do	11 6		300	Do.
119	0.41	28.70	52.70	18.19	do	2 6	V W.	P. vein	Three miles south of Wilkeson.

a Lost. *b* Iron ore.

TABLE 46.—*Analyses of commercial samples from the coal-fields of Washington territory*—Continued.

ANALYSIS.						COAL-BED.				
Number.	Moisture.	Volatile combustible matter.	Fixed carbon.	Ash.	Coke.	Thickness represented.	Columnar number.	Name or field number.	Locality.
						Ft. In.			
120	0.45	27.62	52.04	19.89	do	3 6	V W.	do	Three miles south of Wilkeson.
121	0.00	28.91	56.16	14.93	Fair	8 0	V W.	do	Do.
122	0.02	24.34	52.72	22.92	Good	5 4		108 top	Evans creek, Wilkeson field.
123	0.02	25.80	56.51	17.67	do	3 2		108 bottom	Do.
124	7.04	31.25	27.75	33.96	None	6 9	CXXIII W.	405	Do.
125	3.98	28.64	54.10	13.28	do	4 10	CXXIII W.	405	Do.
126	0.93	17.14	62.78	19.15	do	3 10		459	Do.
127	0.00	10.02	61.81	28.17	do	5 8		461	Do.
128	2.42	28.75	53.89	14.94	do	4 0		480	Do.
129	2.39	26.42	54.12	17.07	do	7 0		483	Do.
130	0.80	29.28	61.03	8.89	do	4 0		488	Do.
131	0.26	36.76	45.58	17.40	Fair	2 8	11 B. B.	550	Busy brook, Wilkeson field.
132	0.00	23.45	58.08	18.47	None	4 9	XXXVII B. B.	578 top	Do.
133	0.35	19.17	38.43	42.05	do	1 0	XXXVII B. B.	578 middle	Do.
134	0.28	29.94	54.15	15.63	Dense	7 0	XXXVII B. B.	578 bottom	Do.
135	0.44	5.84	73.98	19.74	None	2 0	XLIV B. B.	586	Do.
136	0.61	29.58	56.18	13.63	Poor	7 7	LVIII B. B.	601	Do.
137	0.54	5.86	56.98	36.62	None	6 4	LX B. B.	602	Do.
138	0.44	29.65	52.74	17.17	Fair	4 0	LX B. B.	619	Do.
139	0.60	28.48	45.25	25.67	do	16 11		641 bottom	Do.
140	0.64	27.83	51.48	20.65	Dense	3 3		641 top	Do
	0.80	40.87	46.39	11.94	Fair				Picked coal from Upper Yakima, Washington territory.

ANALYSES

OF

COALS AND LIGNITES OF THE NORTH-WEST,

AND

EXPERIMENTS ON THE CONVERSION OF THE LIGNITES INTO A FUEL OF HIGH HEATING POWER.

ANALYSES OF COALS AND LIGNITES OF THE NORTHWEST.

By F. A. Gooch.

In preparing these coals for analysis the usual method of exposing the powdered material during twenty-four hours previous to analysis at ordinary temperatures and under ordinary atmospheric conditions was followed at c first, but later the exposure lasted forty-eight hours and was made in a perfectly dry atmosphere, over sulphuric acid, instead of in the ordinary air of the balance-room. The mode of preparation of each coal will be apparent in the tabular statement. It was found that in consequence of the variation in the contents of the coals in water according to the atmospheric conditions some examination of their hygroscopicity was a necessity; and, though the capacity of substances in general to take up water depends upon temperature and barometric pressure, as well as upon the hygrometric condition of the atmosphere, it appeared to be quite sufficient for the purpose in hand to adopt a uniform mode of treatment, and expose, in every case, a gram of the powdered material first over sulphuric acid during forty-eight hours, and then, after weighing, over water for the same length of time in a closed vessel provided with double walls to secure a uniform temperature and so prevent the deposition of dew, to weigh and, finally, to heat for an hour at 115° C. and weigh again. By these means, the amounts of water lost at 115° C. d by the coal as taken for analysis, as dried over sulphuric acid, and as fully saturated hygroscopically, became known. In most cases the period of exposure is ample, and in the few in which it may, perhaps, be not quite enough, the condition of the coal under examination falls so little short of dryness or aqueous saturation, as the case may be, that the error is not considerable. Experiment indicates that the hygroscopic character of the powder is not materially different from that of the coal in the lump, but changes naturally proceed through the mass of the former with far greater rapidity. In the proximate analysis a gram of material was employed for each process. The water was determined in one portion, as indicated above, by the loss on drying during one hour at 115° C. The total volatile matter was found by igniting a second portion in a covered plantinum crucible by means of a blowpipe flame of sufficient size to envelop the crucible completely, gently at first if the flame showed signs of sparkling, at full heat as soon as the gas evolved began to burn quietly without sparks, and strongly for three e minutes and a half after the gas from the coal had ceased to burn visibly. The loss of weight of crucible and coal under these conditions was taken as the measure of the total volatile material, and the difference between this value and that of the water found by drying at 115° C. is the "volatile combustible matter". The loss of weight of the residue of this treatment when ignited over a Bunsen burner in a free draught of air gave the "fixed carbon", and the difference between the final weight and the weight of the crucible itself was the weight of the ash. Muck's method of treating the ash—moistening with alcohol, evaporating with care, and again igniting before weighing—was found to be effective in compacting the residue and so bringing about complete combustion speedily. The sulphur was estimated by the ignition of a gram of coal with a gram and a half of Eschka's mixture—two parts of magnesic oxide with one part of sodic carbonate—the extraction of the residue with hot water and, after filtering from the insoluble matter, acidifying with hydrochloric acid and boiling to expel free f bromine, precipitation as baric sulphate.

The elementary composition was determined by the combustion of a fourth portion—0.2 gram—in oxygen.

The analytical work was executed by F. A. Gooch, Edward Whitfield, and W. T. Richmond.

TABLE 47.—*Proximate analyses of the*

WASHINGTON TERRITORY.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
1	Wilkeson	Bed cut in the first 1,600 feet of the North Rock tunnel, Carbonado.		2	6
2	do	do		3	0
3	do	do		7	0
4	do	do		5	0
5	do	do		3	6
6	do	do		3	7
7	do	do		4	6
8	do	do		4	6
9	do	do		4	10
10	do	do		5	2
11	do	Carbonado mines	Miller	4	6
12	do	do	Wingate	4	8
13	do	do		8	6
14	do	do		3	0
15	do	do		13	0
16	do	do		7	0
17	do	Near Carbonado	Henry, top	6	0
18	do	do	Henry, bottom	7	0
19	do	3 miles south of Wilkeson	P. bottom bench	5	1
20	do	do	P. top bench	3	2
21	do	do	P. *coke*	8	3
22	do	Fletts creek, near Wilkeson	Smith	6	8
23	do	do	Goodwin	8	0
24	do	do	Gale	5	4
25	do	Old tunnel at Wilkeson	Ainsworth	7	2
26	do	do	Wright	6	0
27	do	Outcrop 2½ miles from Wilkeson	Goodwin	8	0
28	do	3 miles south of Wilkeson	G. bed	5	3
29	do	do	P. bed	8	0
30	do	3 miles south of Wilkeson (part of sample 33)	do		
31	do	do	do	4	9
32	do	do	G. bed	3	5
33	do	do	H. bed	6	4
34	do	1½ mile south of Wilkeson	Kelly	9	0
35	do	do	do	9	0
36	do	do	Coggeshall	3	8
37	do	do	General	6	0
38	do	3 miles south of Wilkeson	H. *coke*	6	4
39	do	do	G. *coke*	5	3
40	do	do	P. vein	2	6
41	do	do	do	3	6
42	do	do	do	8	0
43	do	Near Wilkeson	Gale	4	0
44	do	do	Smith	5	10
45	do	Carbon river	d	2	0
46	do	do	a	5	0
47	do	do	c, top bench	4	6
48	do	do	c, bottom bench	5	2
49	do	From diamond drill-holes near Wilkeson. The samples contain much foreign sand.	Smith	1	2
50	do	do	do	5	0
51	do	do	Goodwin	7	7
52	do	do	Gale	7	0
53	do	do	Black	2	6
54	do	do	do	7	7
55	do	do	do	3	1
56	do	do	Stark	4	1
57	do	Evans creek	120 Scotchman	5	3
58	do	do	do	4	6
59	do	do	488	4	2
60	do	do		?	
61	do	do		?	
62	do	do	108, top	5	4

coals and lignites of the Northwest.

WASHINGTON TERRITORY.

Sampler.	Number of sample.	Number on plate of graphic section.	Proximate analysis. Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{C}{VC}$.	Combustion analysis, see Table 48.	
Willis	1		1.79	32.89	46.23	19.09	0.78	Yellow brown	Good	0.66	2.16	1.40		1
do	2		1.97	29.45	42.36	26.22	3.66	Red brown	Fair	0.95	3.36	1.44		2
do	3		1.78	27.63	51.66	18.93	0.64	do	Poor	0.45	1.94	1.87		3
do	4		2.56	26.49	30.34	40.61	0.42	Dirty white	do	0.71	2.49	1.14		4
do	5		2.22	33.51	44.91	19.36	0.41	Yellow	Fair	0.67	2.45	1.34		5
do	6		1.55	32.37	45.33	20.75	0.78	Reddish	Good	1.47	3.04	1.40		6
do	7		2.10	29.42	36.21	32.27	2.36	Purple brown	do	0.64	2.63	1.23		7
do	8		2.28	32.39	42.89	22.44	2.58	Red brown	do	0.70	2.53	1.32		8
do	9		2.41	32.06	46.64	18.89	0.51	Light buff	do	1.31	2.88	1.45		9
do	10		2.85	28.50	36.26	32.39	0.54	Reddish	Fair	0.81	3.33	1.27		10
do	11		1.69	41.00	48.96	8.35	1.09	do	Very good	1.69	2.91	1.22	1	11
do	12		1.80	42.27	52.11	3.82	0.51	do	do			1.23	2	12
do	13		1.41	33.05	46.63	18.91	0.51	do	Good	1.41	2.07	1.41		13
do	14		1.27	36.22	57.11	5.40	0.99	do	do	0.28	1.76	1.58		14
do	15		4.27	36.24	52.40	7.09	0.36	do	Very poor	0.92	4.54	1.44		15
do	16		6.80	35.10	52.14	5.96	0.33	do	do	1.58	6.80	1.48		16
do	62		2.11	32.15	50.03	15.71	0.55	do	Poor	0.94	3.64	1.56		17
do	63		2.24	32.77	52.56	12.43	0.45	do	do	1.16	3.76	1.60		18
do	64	V W.	1.16	29.09	60.38	9.37	0.41	do	Excellent	0.39	2.05	2.07	10	19
do	65	V W.	1.77	26.16	50.99	21.08	0.45	do	Dense	0.62	2.47	1.95	11	20
do	67	V W.	2.[illegible]4	5.52	84.49	7.85	0.45	Light buff		1.19	3.20			21
do	17	XVIII W.	1.33	25.88	60.67	12.12	0.60	Brownish	Excellent	0.40	1.33	2.34		22
do	18	XVII W.	1.30	27.29	54.01	17.40	0.41	do	do	0.30	2.12	1.98		23
do	19	XVI W.	1.10	24.77	58.86	15.27	1.64	do	do	0.15	1.67	2.38	3	24
do	20	XVII W.	1.22	32.88	50.67	15.23	0.66	Reddish	do	0.31	1.72	1.54	4	25
do	21	XVIII W.	0.78	32.55	46.76	19.91	0.56	do	Good	0.35	1.72	1.44	5	26
do	22	XVII W.	2.03	22.49	57.77	17.71	0.60	Brownish	Excellent	0.49	2.54	2.57		27
do	32	II W.	1.03	26.36	49.69	22.92	0.48	Reddish	Worthless	0.42	2.84	1.88		28
do	33	V W.	3.56	29.01	52.26	15.17	0.39	do	do	0.65	5.08	1.80	6	29
do	34													30
do	35	V W.	2.86	30.86	58.25	8.03	0.56	do	Poor	1.26	4.35	1.88	7	31
do	36	II W.	1.17	27.32	56.36	15.15	0.43	do	Fair	0.68	2.42	2.06	8	32
do	37	I W.	1.54	28.17	59.70	10.59	0.47	Red	Rather poor	0.66	2.77	2.12	9	33
do	60	XVIII W.	1.35	31.84	48.60	18.21	0.49	Reddish	Very poor			1.52		34
do	61	XVIII W.	1.19	32.06	48.14	18.61	0.54	do	Good	0.52	2.73	1.50		35
do	74	XX W.	7.82	35.61	49.75	6.82	0.58	do	None	2.42	8.79	1.54		36
do	75	XVII W.	3.40	30.91	49.48	16.21	0.42	do	do	1.38	4.05	1.60		37
do	72	I W.	1.07	2.73	86.21	9.99	0.52	Red		0.83	1.60			38
do	73	II W.	1.23	3.10	86.14	9.53	0.57	do		0.93	2.06			39
do	119	V W.	0.41	28.70	52.70	18.19		White	Fair	0.41	1.58	1.83		40
do	120	V W.	0.45	27.62	52.04	19.89		do	do	0.45	1.48	1.88		41
do	121	V W.	0.00	28.91	56.16	14.93		do	do	0.00	0.75	1.94		42
do	84	XVI W.	6.03	25.84	51.32	16.81	0.58	Buff	None	1.19	5.85	1.99		43
do	85	XVIII W.	3.87	25.67	60.18	10.28	0.50	Reddish	Very poor	0.53	4.06	2.62		44
do	68	d W.	2.56	8.43	83.27	5.74	1.07	Dark red	None	1.53	3.52	9.88	12	45
do	69	a W.	0.99	25.36	64.41	9.24	0.57	Reddish	Excellent	0.84	1.54	2.54	13	46
do	70	c W.	1.71	17.88	64.40	16.01	0.47	White	None	0.66	2.73	3.60		47
do	71	c W.	1.66	17.65	53.41	27.28	0.44	Light brown	do	0.88	2.45	3.03	14	48
do	90	XVIII W.	1.40	21.17	43.32	34.11	0.42		Fair, but dense			2.05		49
do	91	XVIII W.	1.46	18.73	35.70	44.11	0.56		do	0.41	2.46	1.90		50
do	92	XVII W.	1.36	20.80	41.06	36.78	0.46		Good, but dense	0.41	2.21	1.97		51
do	93	XVI W.	1.13	14.28	21.66	62.93	0.37		Poor	0.53	2.08	1.51		52
do	96	XII W.	0.80	18.14	40.49	40.57	0.47	Pinkish				2.23		53
do	97	XII W.	0.68	22.31	56.16	20.90	0.54	do				2.51		54
do	98	XII W.	0.90	19.72	45.80	33.58	0.46					2.32		55
do	99	XI W.	1.35	18.07	37.78	42.80	0.47					2.09		56
do	100		0.86	9.80	50.93	38.41	0.49	Gray	None	0.20	2.86	5.19		57
do	101		2.24	9.45	57.16	31.15	0.35	Reddish	do	1.04	5.49	6.04		58
do	103		0.37	17.25	45.01	37.37	0.35	Gray	do	0.35	1.70	2.60		59
do	104		0.53	15.47	24.60	59.40	0.48	do	Poor	1.17	1.92	1.59		60
do	105		0.33	14.95	31.85	52.87	0.78	do	do	0.20	1.55	2.13		61
do	122		0.02	24.34	52.72	22.92		Pink	Good	0.02	1.05	2.16		62

TABLE 47.—*Proximate analyses of the coals*

WASHINGTON TERRITORY—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.
				Ft. In.
63	Wilkeson	Evans creek	108, bottom	3 2
64	do	do	405	6 0
65	do	do	405	4 10
66	do	do	459	3 10
67	do	do	461	5 8
68	do	do	480	4 0
69	do	do	483	7 0
70	do	do	488	4 0
71	do	Mishall basin	303 Nisqually Chief, top	6 1
72	do	do	303 Nisqually Chief, middle	6 8
73	do	do	303 Nisqually Chief, bottom	7 3
74	do	do	303 Nisqually Chief, picked coal	.....
75	do	do	354	7 9
76	do	do	352	6 0
77	do	do	341	4 6
78	do	do	341	2 9
79	do	do	300	11 6
80	do	Puyallup area	Several beds	.....
81	Green river	McKay basin	Empire tunnel	4 0
82	do	do		2 10
83	do	do		4 2
84	do	do		3 6
85	do	do		2 8
86	do	do	McKay bed	3 8
87	do	do	do	5 0
88	do	do		9 7
89	do	do		4 4
90	Green river	McKay basin	Top bench	4 3
91	do	do	Bottom bench	5 0
92	do	Lizard mountain	Mammoth	6 4
93	do	do	do	9 7
94	do	Northern field		2 5
95	do	do		4 0
96	do	do		4 11
97	do	do		5 3
98	do	do		4 3
99	do	do		2 8
100	do	Northwestern part of Green River field		7 5
101	do	do	Scenery vein, top	3 10
102	do	do	Scenery vein, bottom	8 2
103	do	Northern part Green River field		3 9
104	do	Lower Green River *lignite*		2 6
105	do	do		4 5
106	do	do		7 0
107	do	do		5 0
108	do	do		8 0
109	do	do		15 3
110	Busy brook	Busy brook	550	2 8
111	do	do	578, top	4 9
112	do	do	578, middle	1 6
113	do	do	578, bottom	7 0
114	do	do	586	2 0
115	do	do	601	7 7
116	do	do	602	6 4
117	do	do	619	4 0
118	do	do	641, bottom	16 11
119	do	do	641, top	3 3
120	Newcastle	Newcastle *lignite*	No. 2 vein	9 8
121	do	do	do	9 10
122	do	do	do	10 5
123	do	do	Bagley vein	7 6
124			Section 12; 8-foot vein; small pieces from top seam	.....
125			Section 12; 8-foot vein; from foot-wall	.....

and lignites of the Northwest—Continued.

WASHINGTON TERRITORY—Continued.

Sampler.	Number of sample.	Number on plates of graphic sections.	Proximate analysis. Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{C}{VC}$.	Combustion analysis, see Table 38.	
Willis	123		0.02	25.80	56.51	17.67		White	Good	0.02	0.78	2.19		63
do	124	CXXIII W.	7.04	31.25	27.75	33.96		do	None	7.04	14.49	0.88		64
do	125	CXXIII W.	3.98	28.64	54.10	13.28		do	do	3.98	11.27	1.88		65
do	126		0.93	17.14	62.78	19.15		do	do	0.93	4.13	3.66		66
do	127		0.00	10.02	61.81	28.17		do	do	0.00	3.05	6.16		67
do	128		2.42	28.75	53.89	14.04		Yellowish	do	2.42	8.88	1.87		68
do	129		2.39	26.42	54.12	17.07		do	do	2.39	8.36	2.04		69
do	130		0.80	29.28	61.03	8.89		Red	Worthless	0.80	3.95	2.08		70
do	110		1.06	24.41	47.19	27.34	0.54	White	Good	0.81	2.61	1.93		71
do	111		1.24	22.65	47.93	28.18	0.44	do	do	0.63	2.73	2.11		72
do	112		1.04	24.12	51.46	23.38	0.54	do	do	0.57	2.28	2.13		73
do	113		0.88	26.09	64.54	8.49	0.51	do	do	0.88	2.73	2.47		74
do	114		1.60	14.04	54.60	29.76	1.55	Yellowish	None	0.61	3.69	3.88		75
do	115		0.91	26.78	47.67	24.64	1.02	White	Good	0.32	2.25	1.78		76
do	116		0.68	25.17	54.78	19.37	0.66	do	do	0.39	1.70	2.17		77
do	117		0.83	22.35	42.79	34.03	1.13	do	do	0.35	2.06	1.91		78
do	118		0.69	24.93	56.91	17.47	0.56	do	Very good	0.25	1.95	2.28		79
do	102		0.85	12.67	69.22	17.26	0.60	Pink	None	0.46	2.61	5.46		80
do	27	XVIII G.	2.50	45.71	48.37	3.42	0.44	Red	Poor	1.28	6.26	1.06		81
do	28	XIV G.	1.80	40.04	40.54	17.62	0.57	Reddish	Rather poor	0.74	5.08	1.00		82
do	29	XIV G.	2.82	40.46	44.58	12.14	0.48	do	Worthless	0.71	5.42	1.10		83
do	30	XV G.	2.51	42.23	44.91	10.35	0.57	Pinkish	Poor	0.96	5.82	1.06		84
do	31	XXIII G.	3.89	38.47	42.01	15.63	0.37	White	None	1.47	8.88	1.09		85
do	46	XVIII G.	11.43	43.21	38.45	6.91	0.37	Pale red	do	5.94	16.09	0.89		86
do	47	XVIII G.	2.73	48.66	44.42	4.19	0.47	Red	Rather poor	1.54	5.64	0.91	15	87
do	48	XXIII G.	3.25	38.49	39.35	18.91	0.53	Reddish	Worthless	1.81	6.77	1.02		88
do	49	XV G.	1.84	42.45	45.90	9.81	0.55	Red	Poor	1.83	5.93	1.08		89
do	88	XVIII G.	3.39	38.18	41.85	16.58	0.63	Pinkish	Sandy	1.46	6.15	1.10		90
do	89	XVIII G.	3.52	45.98	47.23	3.27	0.73	do	do	1.61	5.84	1.03		91
do	38		2.43	36.33	45.14	16.10	0.50	Reddish	None	2.08	6.67	1.24		92
do	39		4.63	35.51	42.79	17.07	0.50	Brownish white	do	2.31	7.09	1.20		93
do	40	XII G.	4.65	43.81	40.99	10.55	0.56	Reddish	do	2.46	8.36	0.93		94
do	41	X G.	3.29	40.55	43.40	12.76	1.02	do	Sinter	2.09	8.00	1.07		95
do	42	IX G.	4.82	42.02	37.12	16.04	1.06	do	None	1.54	9.34	0.88		96
do	43	VI G.	3.34	39.39	41.49	15.78	0.71	do	do	1.58	7.47	1.05		97
do	44	III G.	2.78	38.54	42.94	15.74	0.60	do	Sinter	1.01	5.91	1.11		98
do	45	III G.	2.24	39.52	48.39	9.85	1.20	do	Worthless	1.27	6.37	1.22		99
do	80		3.00	26.99	46.85	23.16	0.60	White	Very poor	1.23	4.48	1.73	16	100
do	81		12.12	33.25	46.28	8.35	0.33	do	None	3.09	11.63	1.39		101
do	82		15.68	31.28	41.87	11.17	0.35	do	do	2.76	12.90	1.31		102
do	83		2.78	22.39	33.93	40.90	0.65	do	Sinter	0.91	3.80	1.47		103
do	50		8.68	35.90	47.07	8.35	0.61	Bright red	None	4.98	14.41	1.03		104
do	51	40 G.	7.46	37.14	32.20	23.20	0.60	White	do	3.89	12.94	0.87		105
do	55	34 G.	9.35	40.77	47.25	2.63	0.60	Red	do	4.45	15.82	1.16		106
do	56	33 G.	9.98	40.63	41.07	8.32	0.39	Reddish	do	4.70	16.46	1.01		107
do	57	38 G.	8.09	36.48	33.11	22.32	0.52	White	do	3.53	13.89	0.91		108
do	59	(3)	7.27	36.02	28.48	28.23	0.53	do	do	3.35	12.82	0.79		109
do	131	11 B. B.	0.26	36.76	45.58	17.40		Purple	Fair	0.26	3.51	1.23		110
do	132	XXXVII B. B.	0.00	23.45	58.08	18.47		White	Sandy	0.00	2.88	2.47		111
do	133	XXXVII B. B.	0.35	19.17	38.43	42.05		do	Worthless	0.35	2.35	2.00		112
do	134	XXXVII B. B.	0.28	29.94	54.15	15.63		do	Dense	0.28	1.63	1.80		113
do	135	XLIV B. B.	0.44	5.84	73.98	19.74		Yellow	None	0.44	2.70	12.66		114
do	136	LVIII B. B.	0.61	29.58	56.18	13.63		Pink	Friable	0.61	2.27	1.89		115
do	137	LX B. B.	0.54	5.86	56.98	36.62		White	None	0.54	2.27	9.72		116
do	138	LX B. B.	0.44	29.65	52.74	17.17		do	Fair	0.44	3.38	1.77		117
do	139		0.60	28.48	45.25	25.67		do	do	0.60	1.86	1.58		118
do	140		0.64	27.83	51.48	20.05		do	Dense	0.64	1.89	1.84		119
do	23		4.13	42.97	43.36	9.54	0.48	do	None	2.60	12.19	1.01	17	120
do	24		4.16	44.84	43.86	7.14	0.42	do	do	3.03	11.98	0.98		121
do	25		6.50	44.71	41.30	7.40	0.32	Dirty white	do	3.31	12.21	0.92	18	122
do	26		4.18	43.79	40.20	11.83	0.34	White	do	2.81	11.26	0.92	19	123
Driver			1.81	8.13	62.90	27.16	0.37	Grayish white	do	0.81	4.41	7.73		124
do			2.00	8.01	53.02	36.97	0.26	White	do	0.93	4.44	6.61		125

TABLE 47.—*Proximate analyses of the coals*

WASHINGTON TERRITORY—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
126		North Fork Puyallup	Vein A	6	9
127		do	Vein B	4	8
128		do	Vein C		
129		Evans creek	Vein No. 1	9	3
130		do	Vein No. 2	3	6
131		do	Vein No. 3	4	3

MONTANA.

NOTE.—See plates to Mr. Eldridge's Report on *Montana Coal Fields.*

1	Bozeman	Chestnut mine (1881)		3	0
2	do	do		1	6
3	do	Chestnut mine, new tunnel (1882)	5 benches, aggregating	7	1
4	do	Chestnut mine, old tunnel (1882)	Upper middle bench	1	0
5	do	do	Lower middle bench	1	2
6	do	Chestnut mine, opening southeast of house (1882)	Clear coal	2	9
7	do	do	Including clay parting	6	3
8	do	Chestnut mine, Thompson's pit, No. 2 (1882)	Coal alone, aggregating	6	3
9	do	do	Coal and bone and clay, aggregating	9	9
10	do	Maxey's seam	3 benches of coal, aggregating (total thickness 3 feet 7 inches)	1	11
11	do	Tunnel on Sec. 24, T. 2, R. 7, 60 feet from entrance	Upper bench	1	6
12	do	Tunnel on Sec. 24, T. 2, R. 7, 60 feet from entrance	Lower bench, excluding 2-inch parting	3	1
13	do	Tunnel on Sec. 30, T. 2, R. 8, 60 feet from entrance	Upper bench, excluding waste streaks	1	6
14	do	Tunnel on Sec. 30, T. 2, R. 8, 60 feet from entrance	Middle bench, excluding waste streaks	1	8
15	do	Tunnel on Sec. 30, T. 2, R. 8, 60 feet from entrance	Lower bench, excluding waste streaks	3	2
16	do	Incline on Sec. 24, T. 2, R. 8	Lower bench	7	0
17	do	Tunnel on Sec. 26, T. 2, R. 8	*Coal*		
18	do	Tunnel on Sec. 26, T. 2, R. 8	*Coke*		
19	do	New incline on Sec. 32			
20	do	Tunnel on Sec. 24, T. 2, R. 7	Sample from dump		
21	do	Tunnel on Sec. 24, T. 2, R. 7	*Coke*		
22	do	C seam below Sugarloaf			
23	do	Deep pit, between Sugarloaf and Rock tunnel			
24	do	Big tunnel on Sec. 30, T. 2, R. 7	9 benches, aggregating	6	7
25	do	do	*Coke*		
26	do	do			
27	do	Tunnel on Sec. 24, T. 2, R. 7	4 benches, aggregating	3	7
28	do	Sec. 24, T. 2, R. 8	*Best coal*		
29	do	do	*Average coal*		
30	do	Incline on Sec. 24, T. 2, R. 8	Upper bench	0	8
31	do	do	Middle bench	1	0
32	do	do	Lower bench	3	7
33	do	Sec. 22, T. 2, R. 8	Upper bench	0	4
34	do	do	Upper middle bench	1	7½
35	do	do	Middle bench	0	6
36	do	do	Lower middle bench	0	6
37	do	do	Lower bench	1	2
38	do	Incline on Sec. 32, T. 2, R. 8	Top bench	0	5½
39	do	do	Upper middle bench	1	0
40	do	do	Lower middle bench	1	0
41	do	do	Bottom bench	0	8
42	do	Single tunnel on Sec. 24, T. 2, R. 7	Top bench	0	11
43	do	do	Upper middle bench (clay)	0	8
44	do	do	Middle bench	0	10
45	do	do	Lower middle bench	0	8
46	do	do	Upper bottom bench	0	4½
47	do	do	Bottom bench	0	10
48	do	Double tunnel on Sec. 30, T. 2, R. 8	Hanging-wall seam, top bench	1	1
49	do	do	Hanging-wall seam, lower top bench	1	0
50	do	do	Hanging-wall seam, upper middle bench	0	4
51	do	do	Hanging-wall seam, middle bench	0	5
52	do	do	Hanging-wall seam, lower middle bench	0	4

and lignites of the Northwest—Continued.

WASHINGTON TERRITORY—Continued.

Sampler.	Number of sample.	Number on plates of graphic sections.	Proximate analysis. Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{c}{vc}$.	Combustion analysis, see Table 48.	
Driver			1.00	11.48	65.18	22.34	0.54	Pink	None	0.68	3.20	5.67		126
do			0.97	11.03	61.97	26.03	0.47	Yellow white	do	0.64	2.75	5.61		127
do			0.48	13.88	68.11	17.53	0.53	Pink	do	0.44	2.09	4.90		128
do			0.47	24.71	50.50	24.32	0.51	do	Good	0.44	1.91	2.04		129
do			0.98	21.82	46.74	30.46	0.32	White	do	0.57	2.08	2.14		130
do			1.26	25.37	43.97	29.40	0.36	do	do	0.80	2.30	1.73		131

MONTANA.

[The Arabic numbers indicate the figures, the Roman numbers the plates.]

Eldridge	10		3.78	23.08	59.27	13.87	0.66	Red	None	0.77	4.26	2.56		1
do	11		3.91	33.48	52.04	10.57	0.46	Pale red	Cokes	0.83	4.50	1.25		2
do	1	4-IX.	1.03	39.48	41.37	18.12	0.64	Dirty white	Good	1.02	3.38	1.64		3
do	2	5-IX.	0.75	29.00	61.74	8.51	0.66	Reddish	None	0.75	3.04	2.12		4
do	3	5-IX.	0.80	14.68	71.56	12.96	0.58	Dirty white	do	0.19	2.27	4.87		5
do	5	6-IX.	16.48	34.30	40.22	9.00	0.36	White	do	3.61	15.98	1.14		6
do	6	6-IX.	14.01	30.11	32.35	23.53	0.27	do	do	4.94	14.11	1.07		7
do	7	1-IX.	10.64	34.64	42.86	11.86	0.32	do	do	3.94	12.40	1.23		8
do	8	1-IX.	9.79	31.43	38.25	20.53	0.40	do	do	3.16	10.87	1.21		9
do	4	10-IX.	1.58	42.11	48.66	7.65	0.61	Reddish	Good	0.82	4.53	1.15		10
do	9		9.37	35.70	49.77	5.16	0.45	Pale red	None	3.17	10.47	1.39		11
do	10		3.62	35.01	44.50	16.87	0.43	Reddish	do	1.06	4.42	1.27		12
do	11		9.37	33.78	47.19	9.66	0.42	do	do	2.75	10.18	1.39		13
do	12		8.89	35.23	38.76	17.12	0.46	do	do	2.65	10.18	1.10		14
do	13		5.59	34.46	49.41	10.54	0.49	do	do	1.71	6.82	1.43		15
do		44-XI.	2.03	35.07	35.62	27.28	0.57	Pale red	Good	0.77	3.38	1.01		16
do			2.47	27.88	25.89	43.76	1.24	Reddish	Poor	1.20	3.90	0.92		17
do			5.70	6.00	78.09	10.21	0.67	Brownish red		1.88	7.17			18
do			6.69	32.38	39.50	21.43	0.49	White	None	1.96	7.91	1.21		19
do			3.02	36.14	43.45	17.39	0.45	Reddish	do	1.04	4.11	1.20		20
do			5.48	5.84	77.89	10.79	0.43	do		1.35	6.29			21
do			12.51	37.63	32.83	17.03	0.47	White	None	4.34	13.89	0.87		22
do			21.21	34.43	30.80	13.56	0.34	do	do	7.28	21.50	0.89		23
do			2.74	39.63	48.88	8.75	0.65	Gray	Good	1.18	3.91	1.23		24
do			4.48	9.82	76.25	9.45	0.71	Reddish		1.21	3.80			25
do			1.99	37.76	47.43	12.82	0.77	do	Good	0.88	3.41	1.25		26
do			1.83	38.55	50.20	9.62	0.52	do	do	1.10	3.67	1.30		27
do			2.56	38.81	43.04	15.59	1.94	do	do	1.10	3.04	1.10	20	28
do			2.73	34.34	38.85	24.08	0.86	do	do	0.64	3.20	1.13		29
do	1	48-XI.	1.40	34.78	51.54	12.28	0.52	Pink	do	0.96	3.23	1.48		30
do	2	48-XI.	1.36	38.47	44.51	15.66	0.54	do	do	1.06	3.11	1.15		31
do	3	48-XI.	1.52	35.93	39.81	22.74	0.69	Pale red	do	0.71	3.29	1.10		32
do	1	35-X.	11.76	35.69	36.32	16.23	0.47	do	None	6.27	18.56	1.01		33
do	2	35-X.	9.24	35.85	49.34	5.57	0.37	do	do	4.85	15.06	1.37		34
do	3	35-X.	10.85	37.17	44.50	7.48	0.39	do	do	5.82	17.08	1.19		35
do	4	35-X.	8.34	37.94	38.74	14.98	0.36	do	do	4.75	15.08	1.02		36
do	6	35-X.	11.33	35.24	47.67	5.76	0.45	Brownish	do	4.27	15.28	1.35		37
do	1	30-X.	9.98	35.93	44.35	9.74	0.50	do	do	6.26	16.14	1.23		38
do	2	30-X.	4.55	33.12	52.45	9.88	0.53	Red	do	2.72	8.23	1.58		39
do	3	30-X.	2.90	35.45	54.94	6.71	0.57	White	Poor (dense)	1.39	5.14	1.54		40
do	4	30-X.	2.89	36.20	50.08	10.83	0.60	do	do	1.37	5.15	1.38		41
do	1	16-X	1.97	41.55	51.13	5.35	0.54	Very red	Good	0.68	3.31	1.23		42
do	2	16-X	1.76	29.58	26.28	42.58	0.47	Pale red	Poor	0.52	3.41	0.89		43
do	3	16-X	1.12	31.77	49.72	17.39	0.45	Dirty white	Good	0.47	2.82	1.56		44
do	4	16-X	1.60	38.57	50.91	8.92	0.57	Brown	do	1.08	3.59	1.31		45
do	5	16-X	1.78	38.71	45.89	14.12	0.59	Gray	do	1.13	3.38	1.18		46
do	6	16-X	1.66	37.71	46.46	14.17	0.52	Light	Good, rather dense	1.43	3.51	1.23		47
do	1	22-X	1.55	36.61	47.31	14.53	1.28	Brown	Good, but dense	0.89	3.52	1.29		48
do	3	22-X	1.56	37.25	49.41	11.78	0.56	Pale red	Good	0.72	3.30	1.32		49
do	4	22-X	1.35	30.45	43.22	24.98	0.45	do	Rather poor	0.73	3.36	1.41		50
do	5	22-X	1.46	39.15	47.26	12.13	0.57	White	Good, but dense	0.73	3.13	1.20		51
do	6	22-X	1.09	39.11	43.79	16.01	0.55	Dirty white	Good	0.74	4.12	1.11		52

TABLE 47.—*Proximate analyses of the coals*

MONTANA—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
53	Bozeman	Double tunnel on Sec. 30, T. 2, R. 8	Hanging-wall seam, bottom bench	0	4
54	do	do	Foot-wall seam, top bench	0	4
55	do	do	Foot-wall seam, upper middle bench	0	7½
56	do	do	Foot-wall seam, lower middle bench	0	8
57	do	do	Foot-wall seam, bottom bench	1	2
58	do	Old incline on Sec. 24, T. 2, R. 8 (148 feet down incline)	Top bench	0	7
59	do	do	Upper middle bench	0	11
60	do	do	Lower middle bench	2	3
61	do	do	Bottom bench	0	6
62	do	Incline, Northern Pacific Coal Company, Sec. 24, T. 2, R. 8 (148 feet down incline).	Middle bench	3	6
63	do	do	Lower bench	4	0
64	do	Tunnel on Sec. 24, T. 2, R. 7 (220 feet from entrance)	Top bench	0	11
65	do	do	Upper middle bench	0	7
66	do	do	Lower middle bench	1	8½
67	do	do	Bottom bench	1	6
68	do	Incline on Sec. 32, T. 2, R. 8 (71 feet from entrance)	Top bench	1	4
69	do	do	3 benches, aggregating	2	9½
70	do	Hyer's claim on Sec. 30, T. 2, R. 8 (33 feet below top of shaft)	5 benches, aggregating	3	9½
71	do	Tunnel on Sec. 24, T. 2, R. 7 (231 feet from entrance)	4 benches, aggregating	4	0½
72	do	Incline Sugarloaf on Sec. 22, T. 2, R. 8 (B seam 38 feet down incline).	do	6	8½
73	do	Incline, Northern Pacific Coal Company, Sec. 24, T. 2, R. 8 (280 feet down incline).	2 benches, aggregating	4	6
74	Bull mountain	Northern Pacific Coal Company's mine, head of Buffalo creek, southeast corner Bull mountains.	Middle bench	3	10
75	do	do	Two lower benches aggregating	2	1
76	do	do	Same as No. 1, 10 feet from it	3	10
77	do	do	Same as No. 2, 10 feet from it	2	1
78	do	W. A. Moody's claim, southwest corner mountains	Lower bench	2	10
79	do	French's claim, head west branch of Buffalo creek, southwest end mountains.	do	2	10
80	do	Head of Spring creek, north side mountains		4	2
81	do	Head of Clearwater creek, northeast corner mountains	Top bench	2	0
82	do	do	Upper middle bench	3	0
83	do	do	Lower middle bench	2	10
84	do	do	Bottom bench	2	3
85	do	Samuel Salisbury's claim, southwest end mountains	Lower bench	2	5
86	do	do	Middle bench	3	11
87	do	do	Lower and middle benches (with 1 parting)	6	6¼
88	do	E. Thomas' claim, south end mountains	Lower middle bench	2	8
89	do	do	Upper middle bench	4	0
90	do	Second gulch west of Billings's Coal Company's claim, southeast end mountains.	Two middle benches (with 1 parting)	6	6¼
91	do	do	Two upper benches (with 1 parting)	4	3
92	do	Near head Middle forks, Wild Horse creek, west end mountains	Middle and lower benches (with 1 parting)	6	4
93	do	Near junction two forks Wild Horse creek, west end mountains	Lower bench	2	3
94	do	do	Middle bench	3	10
95	do	New head of North fork Parrot creek, north end mountains	do	3	8
96	do	do	Upper bench (with 2 partings)	4	10½
97	do	First gulch west of Parrot creek, north end mountains	Middle bench (with 2 partings)	3	6¾
98	do	First gulch east of Parrot creek, northeast end mountains	Two lower benches (with 1 parting)	4	10
99	do	West fork Thaddy creek, northeast end mountains	Bottom bench (with 1 parting)	4	9½
100	do	do	Middle bench (with 2 partings)	4	7
101	do	do	Top bench	2	1
102	do	First gulch east of main fork Thaddy creek, north side east spur.	Upper middle bench	5	0
103	do	do	Middle bench	2	4
104	do	do	Lower bench	2	7
105	do	2 miles south of above, north side east spur	Lower bench (with 1 parting)	4	4½
106	do	do	Middle bench (with 2 partings)	5	2
107	do	do	Top bench	1	10
108	do	Eastern extremity east spur	Middle bench (with 2 partings)	5	7½
109	do	do	Upper lower bench	2	10
110	do	do	Bottom bench	2	2

and lignites of the Northwest—Continued.

MONTANA—Continued.

Sampler.	Number of sample.	Number on plates of graphic sections.	PROXIMATE ANALYSIS. Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{c}{vc}$.	Combustion analysis, see Table 43.	
Eldridge	7	22-X	1.98	36.47	48.94	12.61	0.91	Gray	Good	0.96	4.01	1.34		53
do	8	22-X	1.54	39.89	49.92	8.65	0.67	Reddish	do	0.64	3.83	1.25		54
do	9	22-X	1.68	39.98	48.78	9.56	0.84	do	do	0.87	3.56	1.22		55
do	10	22-X	1.87	36.00	47.96	14.17	0.62	Gray	Good, but dense	0.93	4.01	1.33		56
do	11	22-X	1.92	38.45	50.11	9.52	0.64			1.92	4.71	1.30		57
do	I'''	49-XI	0.97	30.90	42.80	25.33	0.47	Pink	Poor	0.76	3.04	1.38		58
do	II'''	49-XI	1.10	32.81	40.87	25.22	0.50	do	do	0.59	2.93	1.24		59
do	III'''	49-XI	1.46	34.05	37.57	26.92	0.59	Pinkish	Good	0.52	3.03	1.10		60
do	IV'''	49-XI	1.23	40.74	42.53	15.50	0.79	Pink	do	0.67	3.05	1.04		61
do	V'''	50-XI	1.22	36.86	41.54	20.38	0.68	White	do	0.75	3.10	1.12		62
do	VI'''	50-XI	0.93	39.05	45.94	14.08	0.68	Light red	do	0.85	3.04	1.17		63
do	VII'''	17-X	1.13	41.18	53.91	3.78	0.59	Very red	Good, but dense	0.97	4.04	1.30	26	64
do	VIII''		1.69	25.30	21.81	51.20	0.64	Yellowish	Sandy	1.26	4.61	0.86		65
do	IX'''		1.27	36.94	52.62	9.17	0.58	Red	Fair	1.08	3.64	1.42	27	66
do	X'''		1.29	35.52	43.44	19.75	0.52	Pink	do	1.11	3.38	1.22	28	67
do	XII'''	31-X	4.81	33.90	36.49	24.80	0.50	do	None	2.61	9.67	1.07		68
do	XI'''	31-X	2.49	35.37	48.74	13.40	0.66	Pinkish	do	1.93	5.19	1.37		69
do	XIII'''	26-X	8.20	34.18	45.15	12.47	0.50	Pink	do	2.95	12.18	1.32		70
do	XIV'''	18-X	1.57	35.66	48.88	13.89	0.58	do	Fair	0.59	3.19	1.37		71
do	XV'''		3.50	34.66	53.17	8.67	0.52	do	None	1.52	6.04	1.53	29	72
do	XVI'''	51-XI	1.31	34.66	42.01	22.02	0.57	do	Good	0.66	2.74	1.21	30	73
Eldridge	1		14.70	35.14	46.05	4.11	1.50	Red	None	2.47	16.17	1.33		74
do	2		14.72	34.86	44.14	6.28	2.04	White	do	2.28	15.82	1.26		75
do	3		16.59	35.33	44.29	3.79	0.56		do	2.30	16.41	1.25		76
do	4		14.10	36.66	41.91	7.33	0.80	White	do	2.06	15.77	1.14		77
do	5		16.06	38.76	42.05	3.13	0.74	Red	do	4.63	18.04	1.08		78
do	6		14.37	35.57	44.88	5.18	1.84	White	do	3.50	17.39	1.26		79
do	7		14.83	35.74	42.46	6.97	1.37	Pale red	do	3.76	17.67	1.18		80
do	8		13.18	37.51	45.16	4.15	1.12	Very red	do	4.54	15.85	1.20		81
do	9		12.84	37.47	43.19	6.50	1.87	Pale red	do	3.40	15.89	1.15		82
do	10		12.96	39.48	41.67	5.89	0.60	White	do	2.72	14.96	1.05		83
do	11		14.76	37.21	43.95	4.08	0.60	do	do	3.05	16.95	1.18		84
do	I	43-XIX	5.74	36.97	52.61	4.68		do	do	5.74	16.10	1.42		85
do	II	43-XIX	5.02	39.98	49.56	5.44		Red	do	5.02	15.17	1.23		86
do	III	43-XIX	6.20	38.13	50.89	4.78		Pink	do	6.20	16.16	1.33		87
do	IV	47-XX	4.15	38.16	52.08	5.61		White	do	4.15	15.70	1.36		88
do	V	47-XX	4.98	38.81	50.10	6.11		Pink	do	4.98	15.37	1.29		89
do	VI	50-XX	5.03	39.03	49.40	6.54		White	do	5.03	15.31	1.26		90
do	VII	50-XX	7.14	41.25	44.85	6.76		do	do	7.14	16.77	1.08		91
do	VIII	42-XIX	4.71	39.39	50.65	5.25		Pink	do	4.71	14.86	1.28		92
do	IX	41-XIX	5.10	37.44	49.81	7.65		White	do	5.10	15.12	1.33		93
do	X	41-XIX	8.40	42.95	41.28	7.37		Pink	do	8.40	19.08	0.96		94
do	XI	36-XIX	2.40	41.24	50.41	5.95		White	do	2.40	11.82	1.22		95
do	XII	36-XIX	8.66	40.10	42.63	8.61		do	do	8.66	19.03	1.06		96
do	XIII	33-XIX	5.55	36.93	51.15	6.37		Pink	do	5.55	15.78	1.38		97
do	XIV	32-XVIII	7.09	47.44	39.96	5.51		do	do	7.09	17.99	0.84		98
do	XV	29-XVIII	5.42	39.19	48.06	7.33		do	do	5.42	15.29	1.22		99
do	XVI	29-XVIII	4.87	38.90	51.02	5.21		White	do	4.87	14.57	1.31		100
do	XVII	29-XVIII	4.77	37.40	50.51	7.32		Pink	do	4.77	13.78	1.35		101
do	XVIII	25-XVIII	10.47	46.11	37.30	6.12		Red	do	10.47	21.88	0.80		102
do	XIX	25-XVIII	9.70	41.93	40.88	7.49		do	do	9.70	19.60	0.97		103
do	XX	25-XVIII	9.30	43.29	42.20	5.21		do	do	9.30	20.08	0.97		104
do	XXI	23-XVIII	9.48	45.08	38.93	6.51		White	do	9.48	20.26	0.86		105
do	XXII	23-XVIII	6.56	39.09	49.66	4.69		Very red	do	6.56	16.55	1.27		106
do	XXIII	23-XVIII	7.90	40.00	46.76	5.34		do	do	7.90	17.55	1.11		107
do	XXIV	21-XVIII	10.39	46.43	35.11	8.07		Red	do	10.39	21.32	0.75		108
do	XXV	21-XVIII	7.64	41.67	38.98	11.71		Greenish	do	7.64	19.42	0.93		109
do	XXVI	21-XVIII	4.73	36.45	48.45	10.37		White	do	4.73	16.04	1.32		110

TABLE 47.—*Proximate analyses of the coals*

MONTANA—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
111	Bull mountain	Eastern extremity, east spur	Upper lower and bottom benches, together with parting	4	4
112	do	3 miles west of above, south side east spur	Lower bench (with 2 partings)	5	6
113	do	1½ mile west of Sample XXVIII	do	5	10
114	do	Same as Sample XXVIII	Upper bench (with 3 partings)	7	10
115	do	South side of mountain, 4 miles east of N. P. Coal Company's mine.	Lower bench (with 2 partings)	5	9¼
116	do	do	Upper bench (with 1 parting)	7	10
117	do	South side of mountain, 3 miles east of N. P. Coal Company's mine.	Lower bench (with 1 parting)	6	10
118	do	do	Middle bench (with 1 parting)	5	3
119	do	South side of mountain, ½ mile east of N. P. Coal Company's mine.	Lower middle bench	3	0
120	do	do	Upper bench	6	3
121	do	do	Lower bench (with 1 parting)	6	1½
122	do	Jaycox claim, southeast end mountains	Upper bench (with 1 parting)	6	0½
123	do	do	Upper part of XXXVII	3	1
124	do	do	Lower part of XXXVII	2	11
125	do	Billings coal claim, south side of mountain, 3 to 4 miles west of N. P. Coal Company's mine.	Lower bench (with 1 parting)	6	10
126	do	do	Upper bench (with 3 partings)	7	5
127	do	do	Lower part of XLI	3	0
128	do	do	Upper part of XLI	3	8
129	do	Martin O'Brien's claim, southeast end mountain	Middle bench	3	6
130	do	do	Lower bench	3	2
131	Judith basin	Jeneaux, Big spring			10
132	do	do		1	7
133	do	O. Richette, 3 to 4 miles northwest of Sample V′		1	5
134	do	Big Spring		1	8
135	do	Murphy's, near Utica		1	6
136	do	Sage Creek outcrop (9 feet 3 inches of coal)	Lower bench	3	4
137	do	do	Middle bench	4	3
138	do	do	Upper bench	1	8
139	do	do	Lower half of VII′		
140	do	do	Specimens of bone		
141	do	Wolf Creek outcrop (same seam as on Sage creek)	Lower bench (good coal)		6
142	do	do	Bright coal	2	0
143	do	do	Bluish coal		10
144	do	do	Upper bench	2	3
145	do	do	Upper part of XIV′		6
146	do	Mann's ranch, Otter creek		1	5
147	do	Millard's coal, Belt creek, near Kastner's	Lead-colored coal		6
148	do	do	Equivalent of XXI′	1	11¾
149	do	do	Equivalent of XXII′		3
150	do	do	Upper bench, equivalent of XXIII′	2	10
151	do	Kastner's, on Belt creek	Lower bench	2	3½
152	do	do	Lead-colored coal		5
153	do	do	Upper coal, equivalent of XXIV′ and XXVI′	3	0
154	do	do	Equivalent of XXVI′		
155	do	do	Equivalent of XXVII′		
156	do	do	Upper bench	3	5
157	do	do	Lower bench		
158	do	McGiffen's, Sand coulée	Upper part lower bench	1	10
159	do	do	Lower part upper bench	1	5
160	do	Bywater's, Sand coulée (near surface)	Lower bench	2	7
161	do	do	Upper bench	3	4
162	Rock creek	Yankee Jim claim, B seam	Bottom bench	2	0
163	do	do	Lower middle bench	2	4
164	do	do	Upper middle bench	1	8
165	do	do	Top bench with two partings (one ¾ inch thick in sample)	3	2
166	do	Yankee Jim claim, C seam	Lower two benches with 4-inch partings (omitted from sample)	4	11
167	do	Yankee Jim claim, G seam	Middle bench	3	6½
168	do	Yankee Jim claim, F seam	Three benches aggregating	3	10½
169	do	do	do	4	5¼
170	do	Yankee Jim claim, E seam	With two streaks of bone (omitted from sample)	5	7

and lignites of the Northwest—Continued.

MONTANA—Continued.

Sampler.	Number of sample.	Number on plates of graphic sections.	PROXIMATE ANALYSIS. Water.	Volatile combustible matter.	Fixed carbon.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{c}{vc}$.	Combustion analysis, see Table 48.	
Eldridge	XXVII	21-XVIII	6.80	38.77	44.11	10.32	.....	White	None	6.80	18.65	1.13	.....	111
do	XXVIII	15-XVII	4.21	28.21	60.99	6.59	.....	do	do	4.21	15.48	2.16	.....	112
do	XXIX	12-XVII	4.89	39.84	48.89	6.38	.....	do	do	4.89	16.39	1.22	.....	113
do	XXX	15-XVII	5.29	48.95	40.66	5.10	.....	Pink	do	5.29	15.53	0.83	.....	114
do	XXXI	9-XVII	7.76	43.65	41.99	6.60	.....	do	do	7.76	18.87	0.96	.....	115
do	XXXII	9-XVI	5.39	38.44	51.99	4.18	.....	do	do	5.39	16.29	1.35	.....	116
do	XXXIII	6-XVI	4.08	39.03	50.50	6.39	.....	White	do	4.08	13.49	1.29	.....	117
do	XXXIV	6-XVI	6.53	42.38	46.48	4.61	.....	Pink	do	6.53	17.24	1.33	.....	118
do	XXXV	3-XVI	3.80	39.79	51.22	5.19	.....	White	do	3.80	14.40	1.28	.....	119
do	XXXVI	3-XVI	3.84	39.76	51.09	5.31	.....	do	do	3.84	14.20	1.28	.....	120
do	XXXVII	1-XVI	5.22	38.69	50.32	5.77	.....	do	do	5.22	13.96	1.30	.....	121
do	XXXVIII	1-XVI	6.74	37.88	49.91	5.47	0.89	Pink	do	6.74	15.43	1.31	31	122
do	XXXIX	1-XVI	5.19	37.35	50.97	6.49	0.48	White	do	5.19	13.35	1.36	32	123
do	XL	1-XVI	6.18	36.29	51.73	5.80	.....	do	do	6.18	16.07	1.42	33	124
do	XLI	51-LXXIV	6.08	36.16	51.80	5.96	0.73	do	do	6.08	15.18	1.43	.....	125
do	XLII	51-LXXIV	9.11	43.24	41.42	6.23	.....	Red	do	9.11	18.83	0.95	.....	126
do	XLIII	51-LXXIV	5.74	38.35	50.60	5.31	.....	White	do	5.74	15.03	1.31	.....	127
do	XLIV	51-LXXIV	6.13	37.94	50.65	5.28	.....	do	do	6.13	14.98	1.33	.....	128
do	XLV	53-LXXIV	5.46	39.98	47.93	6.63	.....	do	do	5.46	14.27	1.19	.....	129
do	XLVI	.....	5.30	38.39	50.19	6.12	.....	do	do	5.30	14.57	1.30	.....	130
do	II′	.....	3.66	29.73	43.06	23.55	4.46	Pinkish	do	2.02	9.26	1.44	.....	131
do	III′	.....	4.26	33.50	41.12	21.12	5.01	do	do	1.59	9.87	1.22	.....	132
do	IV′	.....	4.30	17.03	56.98	21.69	1.99	Yellowish	do	2.90	8.03	3.34	.....	133
do	V′	.....	7.38	35.67	40.85	16.10	1.22	do	do	5.26	14.21	1.14	.....	134
do	VI′	.....	4.56	28.44	41.90	25.10	2.12	Pink	do	2.70	8.70	1.47	.....	135
do	VI′	.....	4.14	29.70	40.90	25.26	10.83	Pinkish	do	2.34	10.41	1.37	.....	136
do	VII′	.....	6.82	36.74	41.53	14.91	1.38	Pink	do	3.07	10.54	1.13	21	137
do	VIII′	.....	6.54	36.09	45.10	12.27	1.50	White	do	3.27	11.16	1.24	22	138
do	IX′	.....	7.91	36.62	46.00	9.47	1.48	Red	do	3.23	11.36	1.25	.....	139
do	X′	.....	3.35	20.87	38.53	37.25	1.11	White	do	1.38	7.44	1.84	.....	140
do	XI′	.....	6.28	35.78	45.76	12.18	1.83	Yellowish	do	3.29	12.70	1.24	.....	141
do	XII′	.....	6.25	37.47	44.19	12.09	1.49	Pink	do	3.45	12.81	1.17	23	142
do	XIII′	.....	6.30	33.98	37.09	22.63	0.91	White	do	3.43	11.26	1.12	.....	143
do	XIV′	.....	8.52	38.76	44.11	8.61	1.48	do	do	6.05	16.88	1.13	.....	144
do	XV′	.....	8.00	40.79	22.37	28.84	0.96	Yellowish	do	5.13	16.01	0.54	.....	145
do	XVI′	.....	7.81	33.49	42.45	16.25	0.50	White	do	3.43	13.25	1.26	.....	146
do	XVII′	.....	2.11	25.35	38.69	33.85	1.00	do	do	0.97	3.21	1.52	.....	147
.....	XVIII′	.....	2.66	37.63	49.63	10.08	2.76	do	Good but dense	1.28	4.20	1.31	.....	148
.....	XIX′	.....	2.28	33.55	54.51	9.66	2.54	White	None	1.23	5.44	1.62	.....	149
.....	XX′	.....	4.22	26.70	50.89	18.19	1.71	Pink	None	1.73	7.07	1.90	.....	150
.....	XXI′	.....	3.53	38.46	47.65	10.36	3.79	White	Good but dense	1.04	5.14	1.23	24	151
.....	XXII′	.....	1.47	22.91	43.67	31.95	1.53	do	Worthless	0.49	4.19	1.32	.....	152
.....	XXIII′	.....	1.76	28.89	50.57	18.78	2.82	do	None	0.48	5.47	1.75	25	153
.....	XXIV′	.....	1.58	27.18	48.85	22.39	0.38	do	do	0.49	4.66	1.79	.....	154
.....	XXV′	.....	1.76	39.15	18.24	40.85	2.47	do	Fair	0.71	5.57	0.46	.....	155
.....	XXVI′	.....	2.13	25.92	50.87	21.08	2.06	do	None	0.57	5.03	1.96	.....	156
.....	XXVII′	.....	2.37	39.52	49.31	8.80	3.24	do	Fair but dense	1.03	5.05	1.24	.....	157
.....	XXVIII′	.....	2.92	28.86	47.27	20.95	5.23	None	Pink	0.56	7.83	1.63	.....	158
.....	XXIX′	.....	2.20	26.48	45.07	26.25	3.67	do	do	0.47	7.77	1.70	.....	159
.....	XXX′	.....	8.47	40.33	33.46	17.74	0.89	Red	do	4.02	16.29	0.82	.....	160
.....	XXXI′	.....	8.62	32.73	39.20	19.45	0.85	White	do	4.84	15.95	1.19	.....	161
Wolff	A	.....	2.18	46.93	48.12	8.77	2.01	Pink	do	2.18	9.40	1.17	35	162
do	B	.....	2.08	43.70	47.89	6.33	.....	do	do	2.08	8.39	1.09	.....	163
do	C	.....	4.52	38.06	41.76	15.66	.....	do	do	4.52	12.37	1.09	.....	164
do	D	.....	5.37	44.76	38.54	11.33	.....	Yellowish white	do	5.37	14.97	0.86	.....	165
do	E	.....	6.91	48.41	37.37	7.31	.....	Very red	do	6.91	21.22	0.77	.....	166
do	F	.....	5.55	39.79	49.57	5.09	.....	Red	do	5.55	16.76	1.24	.....	167
do	G	.....	3.78	38.13	44.34	13.75	.....	do	do	3.78	13.17	1.16	.....	168
do	H	.....	5.09	38.67	49.97	6.27	.....	do	do	5.09	.....	1.29	.....	169
do	I	.....	4.80	38.40	49.32	7.48	.....	do	do	4.80	14.17	1.28	.....	170

TABLE 47.—*Proximate analyses of the coals*

MONTANA—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
171	Rock creek	Yankee Jim claim, seam below C		2	7½
172	do	Six miles above Clark's fork		1	8½
173	Gallatin valley	Head of Sixteen-Mile creek, Gallatin county			
174	do	do			
175	do	do			
176	do	do			
177	do	do			
178	do	do			
179	do	do			
180	do	do			
181	do	do			
182	do	do			
183	do	do			
184	do	do			
185	do	Star mine, Mullen pass		1	1
186	do	Star mine (1881), Mullen pass		1	0
187	do	Star mine, Mullen pass		1	6
188	do	do		1	6
189	do	do	A few tons at Helena		
190	Hell Gate, Missoula river.	Missoula			
191	do	do			
192	do	do			
193	do	do			
194	do	do	One ton coal on dump		
195	do	do	Specimens of black lignite		
196	do	Near New Chicago		2	0
197	do	do			8
198	Judith basin	Deep creek	Upper bench	4	6½
199	do	do	Layer below sample XXII[1]	0	3
200	do	Eagle rock			
201	do	Deep creek		1	6
202	do	do		5	0
203	do	Kastner's Belt creek	Blacksmith, lower	1	6
204	do	do	Available coal	5	0
205	do	George Heiseman's, Utica		1	8
206	do	Sand coulée			
207	Gardiner	Horr's tunnel	Top bench	0	8
208	do	do	Upper middle bench	0	3½
209	do	do	Lower middle bench	0	9
210	do	do	Bottom bench	0	11
211	do	Horr's opening at wagon-road	Upper middle bench	1	2½
212	do	Horr's opening at upper seam	Top and upper middle benches	2	6
213	do	do	Lower, middle, and bottom benches	[illegible]	4½
214	do	Coke from coal from Horr's tunnel (see samples 1 and 2, above)			
215	do	Horr's mine			
216	do	Cinnabar mountain			
217	do	Gourley and Gillis's mine			
218	do	Opposite Gardiner			
219	do	Trout & Co.'s mine			
220	do	Opposite mouth Gardiner river			
221	do	Reese's claim, Cinnabar mountain			
222	do	Outcrop at mouth of Wild Horse creek			
223	do	Cinnabar mountain			
224	Flathead river	Upper Flathead river			
225	do	do			
226	Sun river, eastern Montana.	Goss Mine No. 2			
227	Eastern Montana	Near Miles City	100-pound sample		
228	do	do			
229	do	Fort Keogh			
230	Dakota	Mouse river			
231	do	do			

and lignites of the Northwest—Continued.

MONTANA—Continued.

Sampler.	Number of sample.	Number on plates of graphic sections.	Proximate analysis. Water.	Volatile combustible matter.	Fixed carbons.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{C}{VC}$	Combustion analysis, see Table 48.	
Wolff	J		4.79	29.33	62.82	3.06	0.90	Bright red	Pink	4.79	12.80	2.14	36	171
do	K		2.06	35.09	43.79	19.06		Red	do	2.06	7.60	1.24		172
do	1 B		8.90	38.14	38.73	14.23		White	do	5.88	14.37	1.01		173
do	2 B		9.51	36.58	39.80	14.11		do	do	6.84	15.64	1.08		174
do	5 B		8.20	33.05	35.67	23.08		do	do	5.75	13.25	1.07		175
do	6 B		8.50	35.14	34.52	21.84		do	do	6.75	15.14	0.98		176
do	7 B		7.12	35.21	39.64	18.03		do	do	6.59	13.54	1.12		177
do	8 B		9.17	35.64	38.06	17.13		do	do	6.59	15.07	1.06		178
do	9 B		11.22	29.03	26.92	32.83		Red	do	4.05	12.41	0.92		179
do	10 B		5.55	11.80	5.91	76.74		Brown	do	0.51	7.59	0.50		180
do	11 B		10.90	31.06	38.56	19.48		Red	do			1.24		181
do	12 B		7.43	28.74	43.64	20.19		Pinkish	do	4.78	12.47	1.51		182
do	X		2.20	36.30	50.71	10.79		Pink	Good	0.58	8.22	1.39		183
do	Y		1.88	35.31	52.05	10.76		White	Poor	0.65	3.28	1.47		184
Eldridge	4		2.82	18.48	47.52	31.18	1.04	do	Good	0.54	3.12	2.57		185
do	5		2.97	23.20	63.30	10.53	0.84	do	do	0.42	3.00	2.72		186
do	6		2.84	20.85	51.28	25.03	0.97	do	do	0.47	3.69	2.45		187
do	7		4.13	19.19	42.23	34.45	1.28	Reddish	do	1.10	5.37	2.20		188
Putnam	1		9.75	42.45	35.01	12.79	2.55	Pink	None	7.04	17.51	0.84		189
R. Pumpelly	1		21.32	33.66	28.10	16.92	1.67	Pale red	do			0.83		190
do	2		19.89	35.89	27.68	16.54	1.80	Brownish	do			0.77		191
do	5		23.39	35.74	31.97	8.90	1.03	Reddish	do			0.89		192
do	Y		23.44	38.08	27.02	11.46	0.98	do	do			0.70		193
Putnam			12.41	41.03	43.65	2.91		Light brown	Poor	6.06	16.23	1.06		194
do			14.47	40.88	41.22	3.43		Yellow red	None	6.63	17.23	1.00		195
do	4		7.89	29.36	7.87	54.88		Very red	do	7.79	20.25	0.26		196
	4½		1.31	22.49	53.79	22.41	1.48	Pink	do	0.80	4.09	2.39		197
Eldridge	XXXII[1]		2.58	31.46	48.22	17.74	2.89	White	None	0.60	5.56	1.53		198
do	XXXIII[1]		1.80	28.63	38.70	30.87	0.98	do	do	0.32	3.55	1.35		199
R. Pumpelly			7.03	36.29	46.54	10.14	1.38	Gray	Worthless	2.48	8.85	1.28		200
do			2.41	23.36	36.68	37.55	3.66	White	None			1.57		201
do			4.30	32.64	48.79	14.27	1.79	do	do			1.49		202
do			3.02	44.22	46.53	6.23	2.80	do	Good			1.05		203
do			2.84	29.30	47.37	20.49	5.38	Purplish	None			1.61		204
do			7.43	30.52	43.69	18.36	2.77	White	do			1.43		205
do			3.35	28.04	46.13	22.48	2.49	do	do			1.64		206
Wolff	1		0.99	37.51	53.50	8.00		Pale red	Good	0.15	1.50	1.42		207
do	2		0.99	39.47	54.39	5.15		do	do	0.40	1.74	1.37		208
do	3		0.95	40.75	53.40	4.90		Pink	do	0.46	1.57	1.31		209
do	4		0.99	19.97	19.78	59.26		White	Worthless	0.27	1.42	0.99		210
do	5		8.88	35.04	49.05	7.03		Pink	None	2.98	9.53	1.39		211
do	6		7.92	36.29	47.49	8.30		do	do	2.65	8.53	1.30		212
do	7		8.89	32.06	48.90	10.15		Red	do	2.61	8.82	1.52		213
do	1		2.12	12.50	77.40	7.98		do						214
do	1		2.81	36.89	53.63	6.67		do	None	0.78	3.68	1.45		215
do	2		3.43	29.28	39.82	27.47	0.87	do	do	0.97	4.20	1.35	34	216
do	1		12.60	37.37	39.81	10.22		Pink	do	5.19	14.35	0.97		217
do	2		11.07	36.58	41.46	10.89		do	do	4.67	12.88	1.13		218
do	1		7.70	35.71	47.76	8.83		Dark red	do	2.91	7.12	1.33		219
do	2		3.18	39.78	48.48	8.56		Pink	Worthless	1.26	4.04	1.21		220
do	1		1.04	35.45	54.24	9.27		do	Fair; dense	0.14	1.63	1.53		221
do	1		22.04	33.11	36.98	7.87		do	None	5.67	15.35	1.11		222
do	2		15.57	33.95	44.23	6.25		do	do	4.34	12.59	1.30		223
R. Pumpelly	1		12.86	45.25	36.80	5.09	1.50	Yellowish red	do	6.16	18.07	0.81		224
do	1 A		3.49	50.03	36.51	9.97	3.71	Red	do			0.72		225
do			2.29	39.32	43.50	14.89	4.29	Very red	Good	1.33	6.34	1.10		226
Eldridge			13.12	33.23	42.66	10.99	0.56	Dirty white	None	5.53	17.67	1.28		227
Willis	79		14.10	36.95	35.76	13.19	0.73	do	do	8.17	18.79	0.97	37	228
Eldridge			13.55	38.39	37.83	10.23	0.55	Reddish	do	6.96	17.82	0.98		229
do	15		14.12	40.56	34.03	11.29	0.68	Buff	do	7.95	21.89	0.83		230
do	17		12.43	36.92	40.49	10.16	0.58	Reddish	do	5.83	18.12	1.09		231

TABLE 47.—*Proximate analyses of the coals*

MONTANA—Continued.

	Field.	Locality.	Name or number of seam.	Thickness represented by sample.	
				Ft.	*in.*
232	Dakota	Mouse river			
233	do	do			
234	do	Lake river			
235	do	Bly mine			
236	do	do			
237	do	do			
238	do	do			
239	do	do			
240	do	Little Missouri			

MISCELLANEOUS ANALYSES.

1	Wyoming	Evanston			
2	New Mexico	Raton			
3	Colorado	El Moro			
4	do	El Moro coke			
5	do	Trinidad, Starkville mines			
6	do	Trinidad, Starkville coke			
7	Washington	Skagit river	Connor	3	5
8	do	Upper Yakima	Picked coal		
9	Oregon	Blue mountains		1	6
10	Oregon, southern	Camas mountain		3	0
11	Idaho?	Float-coal from Kootanai river			
12	Alaska	Admiralty island	Picked coal		

and lignites of the Northwest—Continued.

MONTANA—Continued.

Sampler.	Number of sample.	Number on plate of graphic section.	Proximate analysis. Water.	Volatile combustible matter.	Fixed carbons.	Ash.	Sulphur.	Color of ash.	Character of coke.	Water in dry coal.	Water in saturated coal.	Fuel ratio, $\frac{c}{ve}$	Combustion analysis, see Table 46.	
Eldridge	18		13.07	44.31	36.64	5.98	0.91	Yellowish red	None	5.84	17.21	0.82		232
do	19		11.53	44.06	35.74	8.67	0.72	Reddish	do	7.97	21.88	0.81		233
do	20		13.70	41.94	31.12	13.24	1.05	Yellowish red	do	8.72	23.49	0.74		234
do	21		13.09	39.81	35.58	11.52	1.07	White	do	5.66	17.14	0.89		235
do	22		12.69	43.06	34.34	9.91	1.04	do	do	8.09	20.40	0.79		236
do	23		14.26	37.72	33.20	14.82	0.95	do	do	8.14	19.57	0.88		237
do	24		14.33	38.98	36.18	10.51	1.04	do	do	8.36	20.38	0.92		238
do	25		14.30	43.26	32.57	9.87	1.10	do	do	8.04	19.94	0.72		239
do			12.19	47.81	35.00	5.00	0.52	Reddish	do			0.73		240

MISCELLANEOUS ANALYSES.

R. Pumpelly			7.69	41.61	39.66	11.04	0.29	White	Worthless	3.80	10.28	0.95		1
do			0.98	35.56	48.59	14.87	0.70	do	Poor; dense	0.53	2.20	1.36		2
Eldridge			0.47	34.20	53.17	12.16	0.62	do	Good	0.68	2.15	1.55		3
do			0.31	2.09	82.66	14.94	0.41	Reddish		0.43	1.16			4
do			0.78	32.47	56.81	9.94	0.74	White	Good	0.49	2.04	1.74		5
do			0.30	2.18	78.88	18.64	0.38	Reddish white		0.35	0.90			6
do	76		1.17	14.40	64.56	19.87	0.87	Reddish	Dense	0.62	2.51	4.48		7
do			0.80	40.87	46.39	11.94		Red	Fair; dense	0.80	2.90	1.13		8
do	86		1.08	24.40	34.71	39.81	0.91	do	Worthless	0.02	1.70	1.42		9
do	109		1.53	42.82	44.94	10.71	4.49	do	None	1.53	6.28	1.04		10
	94		0.54	59.61	31.45	8.40	0.65	White	Fluffy	0.13	0.64	0.52		11
	95		3.00	37.96	57.49	1.55	0.73	Yellowish	None	1.43	5.37	1.51		12

TABLE 48.—*Elementary composition of some of the western coals and lignites, dried, ashless, and free from sulphur.*

Territory.	Field.	Samples.	Number of sample.	ANALYSIS.		
				Carbon.	Hydrogen.	Oxygen and nitrogen.
Washington	Wilkeson	Willis	11	81.58	5.37	13.05
Do	do	do	12	82.42	5.60	11.98
Do	do	do	19	84.19	5.25	10.56
Do	do	do	20	85.07	5.40	9.53
Do	do	do	21	83.60	5.66	10.74
Do	do	do	33 and 34	80.35	5.11	14.54
Do	do	do	35	82.91	4.88	12.21
Do	do	do	36	85.23	4.73	10.04
Do	do	do	37	84.01	5.17	10.82
Do	do	do	64	85.71	5.21	9.08
Do	do	do	65	81.33	5.46	13.21
Do	do	do	68	93.43	2.41	4.16
Do	do	do	69	88.41	5.05	6.54
Do	do	do	71	88.23	4.66	7.11
Do	Green river	do	47	78.94	5.72	15.34
Do	do	do	80	83.35	5.16	11.49
Do	Newcastle	do	23	76.82	4.73	18.45
Do	do	do	25	76.43	5.36	18.21
Do	do	do	26	74.57	5.43	20.00
Montana	Bozeman, Sec. 24, T. 2, R. 8, best coal.	Eldridge	Sec. 24, T. 2, R. 8, best coal.	82.53	6.51	10.96
Do	Judith	do	VII′	73.67	3.55	22.78
Do	do	do	VIII′	73.78	3.70	22.52
Do	do	do	XII′	72.48	3.34	24.18
Do	do	do	XXI′	80.17	5.47	14.36
Do	do	do	XXIII′	81.57	4.52	13.91
Do	Bozeman	do	VII‴	81.14	5.39	13.47
Do	do	do	IX‴	82.22	5.24	12.54
Do	do	do	X‴	79.68	5.48	14.84
Do	do	do	XV‴	80.87	4.57	14.56
Do	do	do	XVI‴	81.36	5.77	12.87
Do	Bull mountains	do	XXXVIII	73.79	3.28	22.93
Do	do	do	XXXIX	76.15	2.94	20.91
Do	do	do	XL			
Do	Gardiner	Wolff	Horr's mine, No. 2.	84.39	5.78	9.83
Do	Rock creek	do	A	73.08	4.02	22.90
Do	do	do	J	77.54	0.83	21.63
Do	Miles City	Willis	79	71.80	4.01	24.19

THE CONVERSION OF LIGNITE INTO FUEL OF HIGH HEATING POWER.

By F. A. Gooch. a

The experiments, of which a brief account is here given, were, at the request of Mr. Pumpelly, the Director of the Northern Transcontinental Survey, undertaken in the attempt to make from non-coking lignites of low grade and feeble heating capacity a good locomotive fuel of comparatively high calorific power, and, though the investigation was hardly more than begun when interrupted by the discovery and opening by the survey of the Bozeman coal-field, it has been thought advisable to make record of such facts as were observed.

The problem of the utilization of combustible materials of fragile or pulverulent nature is by no means new, and the number of processes of treatment which have been proposed to this end is very large, but in most of these the product either possesses a calorific value scarcely greater than that of the original material—like the compressed b brown coal of Europe—or is deprived of a portion of its possible serviceability by the admixture of incombustible cements.

Of all known modes of treatment, something like the process of manufacture of the so-called Parisian coal or like that of the Welsh anthracite coke seemed best suited to the case of the lignites, and attention was accordingly turned in these directions. The mode of preparation of the Parisian coal consists, in brief, in the grinding of charcoal refuse with from 8 to 12 per cent. of water, intermixing thoroughly 30 per cent. of coal-tar, molding the magma into cylinders, and coking the last in a muffle furnace. The product is said to be less fragile than ordinary charcoal and more inflammable than coke. The process of manufacture of the Welsh anthracite coke involves the intimate mixture of 60 parts of anthracite coal in fine powder with 35 parts of a good coking coal and 5 parts of coal-tar, and the coking of the mixture beneath a cover of 2 inches of bituminous coal. It is claimed for this c coke that it is about 23 per cent. heavier than the best Welsh coke from bituminous coal, gains only from 1½ to 2 per cent. in weight when moistened with water, burns without decrepitating or crumbling, and is an excellent cupola or blast-furnace fuel. In certain experiments instituted to test this method of utilizing anthracite slack, in connection with the work of the geological survey of Pennsylvania, (*a*) mixtures made according to the Welsh formula failed to yield a product of the requisite coherence for use in the blast-furnace, but a mixture of 50 per cent. of anthracite with 50 per cent. of bituminous coal did yield a fuel said to be capable of bearing the burden of a 75-foot blast-furnace stack, and of good color and structure. Anthracite dust was the base of the coke, but that the dust was quite coarse is evident from specimens of the product kindly sent by Mr. John Fulton, of the Cambria Iron Company, in whose ovens the experiments of the Pennsylvania survey were made, and of that in the metalurgical collection of the National Museum at Washington. A large proportion of this dust must have d failed to pass a screen of five meshes to the linear inch, and it may be that just here, in the degree of comminution of the material previous to coking, the occasion of the difference in quality between the products of these tests and that of the Welsh manufacture is to be sought. At all events, the experiments about to be described certainly point very strongly to the conclusion that the fine pulverization of the materials is of the greatest advantage in securing by coking the homogeneous fusion of bituminous and non-bituminous substances.

The materials employed in these experiments were lignites from several localities on the line of the Northern Pacific Railroad in western Dakota and Montana, bituminous coals from Connellsville, Pennsylvania, from Montana and from Washington territory, the composition of which is given in the following analyses:

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI. e
	Missoula.	Point 100 miles west of Miles City.	Montana (otherwise undescribed).	Little Missouri.	Bly mine.	Wilkeson mine, Washington territory.	Montana.	Connellsville, Pa.	III, partly roasted.	IV, partly roasted.	V, partly roasted.
Water	23.44	21.56	21.26	25.53	23.56	1.22	0.95	1.53	7.68	9.98	9.93
Vol. combustible matter	38.08	38.12	32.34	35.18	35.87	32.88	25.65	30.13	8.86	12.50	12.39
Fixed carbon	27.02	28.29	34.98	33.59	30.71	50.67	55.82	60.17	62.35	60.32	61.58
Ash	11.46	12.03	11.42	5.70	9.86	15.23	17.58	8.17	21.11	17.20	16.10
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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a The composition of the residue after drying or after complete roasting of the lignites out of contact with the air is, of course, readily seen in the figures of analyses I to V.

In experiments 1 to 12, finely-pulverized lignite from Missoula, the composition of which is given in analysis I, was employed with a coal-tar which yielded 33 per cent. of its weight of coke. Small amounts of material, from 5 to 10 grams, were used in each case, and the ignition was effected in closed platinum crucibles within the flame of a large gas blow-pipe, so that the coking might be accomplished at a high heat quickly applied, the most favorable condition for cementing the material and returning the largest yield of coke. In experiments 1 and 2 the lignite was taken in its natural condition; in experiments 3 and 4, after the expulsion of its water of composition, by drying at 115° C.; and in experiments 5 to 12, after thorough roasting out of contact with the air to remove the volatile matter. The proportions used are given in percentages, and the figures corresponding b to different conditions of the lignite are given in each case to facilitate a comparison between the different experiments, but those figures which represent the composition of the lignite for the condition in which it was actually used are put in heavy type.

Materials.	1.	2.	3.	4.	5.	6.
	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.
Natural lignite	**76.9**	**55.6**	65	56.6	95.3	91.6
Coal-tar	**23.1**	**44.4**	35	43.4	4.7	8.4
c Dried lignite			**58.7**	**50**		
Coal-tar			**41.3**	**50**		
Roasted lignite	56.1	32.5	40.2	31.3	**86.7**	**80.7**
Coal-tar	43.9	67.5	59.8	68.7	**13.3**	**19.3**
Treatment					Mixture tamped	Tar at bottom of crucible with lignite above it.
Residue	Not coherent	Coherent but granular and very fragile.	Coherent but granular and very fragile.	Coherent but granular and fragile.	Feebly coherent	Feebly coherent.

Materials. d	7.	8.	9.	10.	11.	12.
	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.	Missoula lignite; coal-tar.
Natural lignite	91.6	91.6	91.6	91.6	86.6	72.2
Coal-tar	8.4	8.4	8.4	8.4	13.4	27.8
Roasted lignite	**80.7**	**80.7**	**80.7**	**80.7**	**71.4**	**50**
Coal-tar	**19.3**	**19.3**	**19.3**	**19.3**	**28.6**	**50**
Treatment	Mixture not tamped.	Mixture tamped	Moistened with naphtha and tamped.	Moistened with water and tamped.	Moistened with water and tamped.	Not tamped.
Residue	Coherent but granular and fragile.	Coherent and hard, but not cellular.	Feebly coherent	Feebly coherent	Feebly coherent	A true coke of fair color and structure.

e It is evident that under the conditions of these experiments a mixture of roasted lignite and coal-tar is capable of producing a firm fuel, as in experiment 8, in which 19.3 per cent of tar was employed, or even a true coke of good structure, as in experiment 12, in which the roasted lignite was mixed with its own weight of tar. The bad effect of the presence of the volatile matter of the lignite is obvious in experiments 1 and 2, an amount of tar more than twice that of the fixed matter of the lignite proving insufficient to produce a firm cementing of the materials, and the removal of the water of composition alone seems to improve the matter little. Tamping, or the compression of the mixture before heating, is advantageous, but, as would be expected from the results of experiments 1 to 4, the addition of volatile matter to the mixture is deleterious; and this effect appears to be due to the mechanical disintegration of the mass by the evolution of gas at the time when the fusion of the particles should be in process, rather than to chemical action, though it would not be unnatural to expect some dissociation of aqueous vapor at f the expense of the carbon, more especially as the application of heat is sudden.

In experiments 13 to 23 bituminous coals, either with or without the addition of coal-tar, were used for the cementing material. In experiments 13 to 17 the roasted lignite of analysis II, the Washington Territory coal of analysis VI, and coal-tar yielding 33 per cent. of coke were employed, and in experiment 18 the same lignite was used with the Montana coal of analysis VII. In experiments 15 to 18 portions of 400 grams were operated upon in fire-clay crucibles in a Fletcher gas-furnace, the crucible being at a red heat when the mixture was introduced. In other cases small portions of a few grams were treated in platinum crucibles as before. In experiments 19 to 23 the lignite from Montana, represented by analyses III and IX, in the natural, dried, partly roasted, and roasted conditions, was used in mixture with the Connellsville coal of analysis VIII.

Materials.	13.	14.	15.	16.	17.	18.
	Lignite 100 miles west of Miles City; Wilkeson coal.	Lignite 100 miles west of Miles City; Wilkeson coal.	Lignite 100 miles west of Miles City; Wilkeson coal; coal-tar.	Lignite 100 miles west of Miles City; Wilkeson coal; coal-tar.	Lignite 100 miles west of Miles City; Wilkeson coal; coal-tar.	Lignite 100 miles west of Miles City; Montana coal; coal-tar.
Natural lignite	90.8	78.8	86.4	88.7	88.1	78.8
Coking coal	9.2	21.2	8.7	9	9.5	18.5
Coal-tar			4.9	2.3	2.4	2.7
Roasted lignite	**80**	**60**	**72**	**76**	**75**	**60**
Coking coal	**20**	**40**	**18**	**19**	**20**	**35**
Coal-tar			**10**	**5**	**5**	**5**
Residue	Firm and dense, but with no cellular structure.	Firm and dense, but with no cellular structure.	Firm and dense, but with no cellular structure.	Firm and dense, but with no cellular structure.	Firm and dense, but with no cellular structure.	Firm and dense, but with no cellular structure.

Materials.	19.	20.	21.	22.	23.
	Montana lignite; Connellsville coal.	Montana lignite; Connellsville coal.	Montana lignite; Connellsville coal.	Montana lignite; Connellsville coal.	Montana lignite; Connellsville coal.
Natural lignite	**50**	**68.3**	68.3	68.3	68.3
Coking coal	**50**	**31.7**	31.7	31.7	31.7
Dried lignite			**62.9**		
Coking coal			**37.1**		
Partly-roasted lignite				**54.5**	
Coking coal				**45.5**	
Roasted lignite	31.9	50	50	50	**50**
Coking coal	68.1	50	50	50	**50**
Residue	Firm, color excellent, structure porous with marks of fusion.	Firm, color fair, structure porous with marks of fusion on surface of contact with crucible.	Firm, color good, structure porous with marks of fusion on exterior surfaces.	A true coke of good color and structure.	A true coke of excellent color and structure.

It appears from the first six experiments of the series just given that a firm fuel may be made under the conditions of the crucible experiments from mixtures containing proportions of coking material very much below those of the Welsh formula, though the Welsh proportions did not yield a true coke. Seventy-five per cent. of roasted lignite, with 20 per cent. of a coking coal (which though good is not to be placed in the same rank with the Connellsville coal) and 5 per cent. of coal tar as serviceable proportions; so, also, is the mixture of 80 per cent. of the roasted lignite and 20 per cent. of the coking coal.

In the last five experiments the proportion of bituminous coal was equivalent to the fixed matter of the lignite and the fuel produced was in every case firm, and in experiments 22 and 23 a true coke; but, as in the experiments in which coal-tar was the sole cementing ingredient, the disadvantageous effect of the presence of volatile matter is clearly traceable, though in the case of the partly-roasted lignites—material taken from that used in experiments on a larger scale, which are about to be described, and which was partly roasted simply because the complete roasting of the large sample was an impossibility with the facilities at command—the influence of the residual volatile matter was comparatively slight. Though, as was evident in the earlier experiments, the cementing quality of tar is adequate to the production of a true coke, these later experiments go to show very plainly that the value of good bituminous coal exceeds that of the same proportion of coal-tar. Thus, while in experiment 2 44.4 per cent. of coal-tar to 55.6 per cent. of lignite in the natural condition is a proportion capable of yielding only a fragile product, in experiment 19 equal parts of natural lignite and Connellsville coal produce a firm fuel of good structure and color, though not a true coke; and in the comparison of experiments 7, 8, and 13, the bituminous coal seems to have the advantage. It is to be noted, however, that the superiority of the coking coal over the tar is particularly obvious when the lignite still retains its volatile matter, and it may be that the advantage of the coal lies in the longer retention, during exposure to high heat, of the capacity to coke, so that a larger proportion of the gaseous matter of the lignite may escape and be out of the way of doing harm before the cementing of the material ceases.

Experiments 24 to 36 were made upon a considerably larger scale, for the purpose of testing the conditions of the coking oven. The materials were taken from the large lots which had been prepared for the final experiments 37 and 38. The roasting of the lignites was effected in retorts ordinarily used for making illuminating gas, and was but partial because it was found necessary to stop the process before completion to prevent the wasting of fixed carbon by the action of the air, which, under the circumstances, could not be entirely excluded. Each charge was drawn as soon as it appeared to be ashing slightly on the surface and drenched at once with water. A mill usually employed in grinding fire-clay offered the only means available for pulverizing the roasted lignite and the bituminous coal, but the conditions imposed in the use of the mill, that the material should be worked in moist

a condition to keep the dust down, effectually prevented the grinding of the materials to that degree of fineness which was greatly to be desired. Much of the ground lignite and coal would scarcely pass a sieve of ten meshes to the linear inch. The mixtures were made in the proportions indicated in the tabular statement, and small portions of each mixture were tested in the crucible after the manner of the experiments previously described. For convenience of comparison the figures corresponding to the proportions of lignite in the mixture for the natural condition and that after complete roasting are given as before in lighter type. The portions experimented upon, varying from 150 to 400 pounds in weight, according as sacks or barrels were used to contain them, were thrown directly upon the hot bottoms of bee-hive ovens from which the charges had just been drawn, immediately covered with the new charge of coking coal, and quenched and drawn with the charge of the oven after forty-eight hours. The analyses of the products are included in the table.

b

Materials.	24.	25.		26.	27.		28.	
	Montana lignite; Connellsville coal; coal-tar.	Montana lignite; Connellsville coal; coal-tar.		Little Missouri lignite; Connellsville coal; coal-tar.	Little Missouri lignite; Connellsville coal; coal-tar.		Bly Mine lignite; Connellsville coal; coal-tar.	
Natural lignite	84.4	84.4		85.5	85.5		85.3	
Coking coal	11.8	11.8		10.9	10.9		11.1	
Coal-tar	3.8	3.8		3.6	3.6		3.6	
Partly-roasted lignite	**75.1**	**75.1**		**75.1**	**75.1**		**75.1**	
Coking coal	**18.8**	**18.8**		**18.8**	**18.8**		**18.8**	
c Coal-tar	**6.1**	**6.1**		**6.1**	**6.1**		**6.1**	
Roasted lignite	71.5	71.5		70.1	70.1		70.1	
Coking coal	21.5	21.5		22.6	22.6		22.6	
Coal-tar	7.0	7.0		7.3	7.3		7.3	
Weight of charge ..... pounds	320	150		150	150		150	
Residue	Firm fuel	Fairly firm fuel		Rather fragile	Weak fuel		Weak fuel	
		Upper.	*Under.*		*Upper.*	*Under.*	*Upper.*	*Under.*
Water	5.98	5.71	4.70	7.21	6.54	6.02	4.84	5.23
V. C	4.33	5.39	3.87	8.51	5.79	7.06	8.07	7.30
C	70.24	69.08	69.50	68.25	70.05	72.11	66.24	65.72
Ash	19.45	19.82	21.93	16.03	17.62	14.81	20.85	21.75
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
d Residue in parallel-crucible experiment	Color excellent, but grain coarse.	Color excellent, but grain coarse.		Color excellent, but grain coarse.	Color excellent, but grain coarse.		Color excellent, but grain coarse.	

Materials.	29.	30.	31.	32.
	Montana lignite; Connellsville coke.	Montana lignite; Connellsville coke.	Montana lignite; Connellsville coke.	Montana lignite; Connellsville coke.
Natural lignite	87.8	84.4	78.5	73
Coking coal	22.2	15.6	21.5	27
Partly roasted lignite	**80**	**75**	**67**	**60**
Coking coal	**20**	**25**	**33**	**40**
Roasted lignite	76.9	71.5	62.9	55.6
e Coking coal	23.1	28.5	37.1	44.4
Weight of charge ..... pounds	400	300	300	300
Residue	Too fragile to be drawn.	Feebly coherent	Firm, but not a true coke.	A fair coke, of good color and structure.
Water		6.53	6.59	2.79
V. C		5.10	6.73	3.09
C		68.89	67.71	75.07
Ash		19.48	18.97	19.05
		100.00	100.00	100.00
Residue in parallel crucible experiments	Color excellent, but grain coarse.	Color excellent, but grain coarse.	Color excellent, but grain coarse.	Color excellent, but grain coarse.

a

Materials.	33.		34.	35.		36.	
	Montana lignite; Connellsville coal.		Montana lignite; Connellsville coal.	Little Missouri lignite; Connellsville coal.		Bly Mine lignite; Connellsville coal.	
Natural lignite	73		64.3	74.8		74.2	
Coking coal	27		35.7	25.2		25.8	
Partly roasted lignite	**60**		**50**	**60**		**60**	
Coking coal	**40**		**50**	**40**		**40**	
Roasted lignite	55.6		45.5	53.8		53.8	
Coking coal	44.4		54.5	46.2		46.2	
Weight of charge ....pounds	150		220	150		150	b
Residue	Good coke, of good color and structure.		Good coke, of good color and structure.	Weak fuel		Fairly firm, of good colo-, but not a true coke.	
	Upper.	*Under.*		*Upper.*	*Under.*	*Upper.*	*Under.*
Water	3.50	5.63	2.79	5.75	3.94	4.97	3.13
V. C	4.29	6.93	3.09	7.60	4.49	8.77	4.37
C	70.71	68.34	75.07	71.93	75.05	70.25	74.87
Ash	21.50	19.10	19.05	14.72	16.52	16.01	17.63
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Residue in parallel crucible experiments	Color excellent, but grain coarse.		Color excellent, but grain coarse.	Color excellent, but grain coarse.		Color excellent, but grain coarse.	

c

Experiments 24 to 28 indicate pretty clearly the lowest proportions of cementing material by the admixture of which with the roasted lignites it may be hoped to secure a good fuel by coking. Why experiments 26, 27, and 28 should have yielded a feebly coherent product under apparently the same conditions of mixture and experimentation which in experiments 24 and 25 gave a firm fuel is difficult to see, unless the cause is to be sought in the larger amount of volatile matter still remaining in the partly-roasted lignite of the first experiments. At any rate it is evident that these proportions lie near the limit of successful cementing. Experiments 29 to 36, with the companion tests, show unmistakably that the conditions of the crucible experiments are more favorable to the production of firm cokes of good color than the conditions which prevail beneath the surface of coal in process of coking in the beehive oven, and a comparison with experiments 13 to 18 and 23 emphasizes the value of a fine comminution of materials. d

In experiments 37 and 38 the materials were mixed for oven charges, as indicated in the table following, and thrown into hot beehive ovens. Heating began immediately, and a coherent crust formed upon each charge, and the surface cracked in an encouraging manner. In the case of experiment 37, however, it was possible to run a pole to the bottom of the oven after eight hours heating, and upon drawing the charge at the end of twenty-four hours the product was worthless excepting the thin surface crust. In experiment 38 the product, drawn twenty-two hours after charging, proved to be a good coherent fuel, but not a true coke. This fuel was used with success on a 27-ton locomotive, and gave every indication of being applicable to locomotive use, and the material was preserved for quantitative tests.

Materials.	37.			38.			e
	Montana lignite; Connellsville coal; coal-tar.	Little Missouri lignite; Connellsville coal; coal-tar.	Bly mine lignite; Connellsville coal; coal-tar.	Montana lignite; Connellsville coal.	Little Missouri lignite; Connellsville coal.	Bly mine lignite; Connellsville coal.	
Natural lignite	84.4	85.5	85.3	73	74.8	74.2	
Coking coal	11.8	10.9	11.1	27	25.2	25.8	
Coal-tar	3.8	3.6	3.6	.....	.....	.....	
Partly roasted lignite	**75.1**	**75.1**	**75.1**	**60**	**60**	**60**	
Coking coal	**18.8**	**18.8**	**18.8**	**40**	**40**	**40**	
Coal-tar	**6.1**	**6.1**	**6.1**	.....	.....	.....	
Roasted lignite	71.5	70.1	70.1	55.6	53.8	53.8	
Coking coal	21.5	22.6	22.6	44.4	46.2	46.2	
Coal-tar	7.0	7.3	7.3	.....	.....	.....	f
Weight of charge ....pounds	2,000	2,000	2,000	1,330	2,730	1,330	
Residue	Thin crust on surface			Fairly firm, but not a true coke.			
Water	.....			.....	6.92		
V. C	.....			.....	7.54		
C	.....			.....	69.24		
Ash	.....			.....	16.30		
					100.00		
Residue in parallel crucible experiments	Color excellent, but grain coarse			Color excellent, but grain coarse.			

a From the experiments which have been cited, it is plain that not only a good fuel but a fuel possessing the qualities of a true coke may be made under the conditions of the crucible experiments from mixtures of roasted lignite with either a coking coal or coal-tar, and the conclusion that the more thoroughly and quickly the heating of the mass takes place the better will be the product seems warranted. Fine pulverization of the materials before coking is shown distinctly to be advantageous in experiments on the small scale, which suggest at least the trial of the same mode of preparation on the large scale. The beehive oven is manifestly unsuited to the coking of material not abundantly charged with bituminous constituents, but some one of the many devices which have been lately put forward as improvements upon the plan of the Belgian ovens would doubtless prove valuable in such cases, some arrangement by which the material may be compressed and coked in thin layers being apparently most promising. Perhaps the most important point which has been brought out by these experiments in reference to b the treatment of lignites by coking in mixture with bituminous materials is the great advantage to be gained in the removal of the volatile constituents before making the mixture to be coked. In the crucible experiments the yield is the sum of the fixed matter of the coal, the lignite and the tar as given by the ordinary proximate analysis; on the working scale it is probable that the waste of fixed carbon need not exceed that which is usual in the coking of bituminous coal. While the experiments have not been carried far enough to warrant a close estimate of the cost of producing the proposed fuel, the results justify the belief that this would not be prohibitory where the alternative was the bringing in of eastern coals.

STATISTICS

OF THE

PRODUCTION OF COPPER IN THE CENSUS YEAR.

TABLE 49.—*Production of copper east of the 100th meridian.*

	State.	County.	Number of mines.	Maximum capacity of yearly production in pounds of metal.	Product census year in tons of ore or rock.	Product census year in pounds of ingot copper.	Value of product.	Value of materials or supplies used.	Wages paid.	Men employed above ground.	Men employed below ground.	Boys employed above ground.	Boys employed below ground.	Total employés.	Miners.	Laborers.
1	Michigan	Houghton	6	41,604,391	794,550	40,389,212	$7,068,111	$1,040,052	$2,171,451	1,840	1,995	105	20	3,960	1,513	2,291
2	....do	Keweenaw	4	7,315,603	79,695	3,764,723	622,826	150,632	392,361	306	447	27	.....	780	392	369
3	....do	Isle Royale	1	80,000	2,000	80,000	14,000	2,500	9,224	17	.....	1	.....	18	10	6
4	....do	Ontonagon	8	1,993,766	62,715	1,596,327	274,295	22,022	88,207	74	170	2	.....	246	161	76
	Total of Michigan		19	50,993,760	938,960	45,830,262	7,979,232	1,215,206	2,661,243	2,237	2,612	135	20	5,004	2,076	2,742
5	Maryland	Carroll	1	29,635	82	7,058	1,200	100	1,500	1	4	1	.....	6	4	2
6	Missouri	Sainte Genevieve	3	3,920,000	1,051	230,717	25,730	2,102	14,059	12	29	.....	.....	41	31	9
7	North Carolina	Ashe	2	4,080,000	24,680	1,640,000	350,000	61,000	133,631	200	103	25	.....	328	103	219
8	Pennsylvania	Montgomery	1	218,400	289	40,460	5,630	363	1,400	4	6	.....	.....	10	3	6
9	Vermont	Orange	1	2,647,894	28,037	2,647,894	469,495	102,479	265,231	262	272	37	48	619	201	406
10	Wisconsin	Iowa	1	31,067	62	18,087	1,549	84	339	1	2	4	.....	7	2	5
	Total		28	61,920,696	993,161	50,414,478	8,832,836	1,381,334	3,077,403	2,717	3,028	202	68	6,015	2,420	3,389

NOTE.—In addition to the above there were returned by Messrs. Pope, Cole & Co. the following amounts of ingot smelted by them, viz: 678 pounds from as having been produced from 17 tons of ore. In Pennsylvania 135,720 pounds of ingot copper, valued at $23,072, were produced in Lancaster county, from ore 270,000 pounds. From Montgomery county, in addition to the amount in the above table, there were produced, according to the smelting schedules, which furnished

The statistics from Maine, New Hampshire, and Tennessee are tabulated separately, because, in the case of the two first mentioned states, the mines are now situated so far from railroad that the value of the ore was returned as nominal. It likewise remained on the dump at the end of the census year.

11	Maine	Hancock	3	672,000	1,225	102,500	$18,040	$9,767	$36,500	38	37	.....	22	97	45	47
12	New Hampshire	Grafton	1	1,000	250	34,050	5,993	635	4,800	3	9	.....	.....	12	8	3
13	Tennessee	Polk	1	205,170	294	153,880	.....	.....	1,200	.....	4	.....	.....	4	4	.....

TABLE 49.—*Production of copper east of the 100th meridian.*

Administrative force.	Number of animals: horses, mules, and oxen.	Number of steam-engines.	Horse-power steam-engines.	Value of all machinery.	Value of explosives.	Cords of wood used for fuel.	Value of wood.	Timber.	Value of timber.	Sawed lumber.	Value of lumber.	Amount of working capital.	Value of plant.	Value of real estate.	Total capital.	
								Linear ft.		*Feet B. M.*						
156	82	76	9,318	$2,059,000	$159,084	68,957	$236,322	727,722	$108,172	2,958,000	$48,896	$785,000	$4,387,000	$23,447,000	$28,619,000	1
19	43	28	2,975	445,000	60,413	32,400	81,200	717,726	6,802	323,244	4,244	195,000	803,185	350,825	1,349,010	2
2	2	2	80	5,000	25	.....	.....	2,000	100	1,500	21	4,000	6,000	10,000	20,000	3
9	9	7	342	51,000	4,575	3,600	9,250	5,800	260	62,000	572	38,000	79,000	308,541	425,541	4
186	136	113	12,715	2,560,000	224,097	104,957	326,772	1,453,248	115,334	3,374,744	53,733	1,022,000	5,275,185	24,116,366	30,413,551	
.....	1	1	50	7,000	180	.....	.....	.....	.....	.....	.....	800	30,000	5,000	35,800	5
1	.....	.....	.....	.....	643	.....	.....	3,200	32	4,000	56	4,150	6,050	5,280	15,480	6
6	47	11	275	34,000	3,100	8,400	21,000	65,000	600	.....	.....	201,000	316,000	76,000	593,000	7
1	.....	1	6	1,000	16	.....	.....	5,000	125	4,200	42	500	1,000	7,000	8,500	8
12	57	3	230	20,800	5,832	4,700	15,275	.....	.....	500,000	6,000	100,000	125,000	275,000	500,000	9
.....	.....	.....	.....	.....	60	.....	.....	.....	.....	.....	.....	75	50	4,500	4,625	10
206	241	129	13,276	2,622,800	233,928	118,057	363,047	1,526,448	116,091	3,882,944	59,831	1,328,525	5,753,285	24,489,146	31,570,956	

Virginia ore, 922 pounds from Georgia ore, and 5.084 pounds from Texas ore, without further known data, and 1,275 pounds from Baltimore county, Maryland, reported containing nickel. The statistics of labor, etc., have been reported on the nickel schedules. The maximum yearly yield of copper from this source is estimated at no further data, 306 tons of ore, containing 38,556 pounds of ingot copper, valued at $6,554.

and the value of the ore could not be determined, none having been smelted previous to the close of the census year; and the mines of Tennessee, though old, are

5	10	5	$215	$10,000	$2,388	1,085	$3,000	5,000	$25	1,000	$100	$4,500	$71,500	$28,000	$104,000	11
1	2	1	20	1,800	160	182	182	25,000	78	.....	.....	1,000	10,000	10,000	21,000	12
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	40	.....	140	13

TABLE 50.—*Production of copper west of the 100th meridian.*

State or territory.	Counties.	Number of mines.	Product census year in tons of ore or rock.	Product census year in pounds of ingot copper.	Value of materials or supplies used.	Wages paid.	Men employed above ground.	Men employed below ground.	Total employés.	Miners.	Laborers.	Administrative force.	Number of animals: horses, mules, and oxen.	Number of steam-engines.	Horse-power steam-engines.	Amount of working capital.	Value of plant.	Total capital.
Total		9	12,560	5,410,546	$90	$94,128	80	50	130	50	73	7	2	1	30	$50,000	$61,500	$111,500
Alaska			17	3,933														
Arizona	Apache	2	7,650	3,183,750		77,128	74	36	110	36	68	6	2			40,000	57,000	97,000
California	Amador	1	4,000	720,000	90	17,000	6	14	20	14	5	1		1	30	10,000	4,500	14,500
Colorado	Arapahoe																	
Do	Jefferson			1,578														
Idaho	Lemhi	2		150,000														
Montana			523	1,212,500														
Nevada	White Pine	4	357	134,730														
New Mexico			13	4,055														

ANALYSIS OF THE COPPER STATISTICS.

By Charles F. Johnson, Jr. (a)

All the ratios between production, wages, capital, number of mines, etc., are so controlled by the figures from one exceptionally productive mine in Houghton county, Michigan, that no general results can be drawn from the c subjoined table which would not be greatly changed, and in some cases reversed, if that mine were excluded from the consideration.

The product is reduced to metallic copper, and its value is given at the mines or at the point where it is no longer operated on by the labor reported in the schedule. In some cases both smelting and mining are carried on by the same establishment; in others the process of reduction is partly carried on at or near the mine, and the product, in the form of a "matte", is shipped to a distance; in others the ores of copper are mined and shipped without any preliminary reduction. Thus the industry, strictly speaking, embraces both mining and manufacturing, in a manner which renders it impossible to separate them.

The only common unit to which these various products can be reduced is evidently metallic copper, the value of which, per pound, to the mine producing, varies greatly, depending upon the expense and labor that must be d laid out upon it before it reaches the general market in the form of merchantable metal.

Under all these various conditions the average price realized by the mines has been 17.52 cents per pound.

The Lake Superior region furnishes 90.90 per cent. of the entire product given in the table. The production of $6,919 worth of native silver is also reported from this region. The 50,414,478 pounds of copper would make a cube whose edge would be 46 feet, or, in other words, would cover 26.73 acres with a sheet 1 inch thick.

The product is reported as equaling 81.57 per cent. of the "maximum capacity" of the mines. "Maximum capacity," however, represents in many cases rather the hopes and wishes of the manager than the probabilities of the mine. From the nature of the case it has a somewhat different significance from what it has when applied to iron or coal mining, where production from time to time outruns demand. The copper mines are worked continuously during the year, and for the industry as a whole "maximum capacity" may be taken to mean rather e the capacity of the machinery than of the mines.

We have regarded the return of "capital employed" as one of the most important we had to make, second only to those of wages and labor. Is is divided into three items of a totally different nature.

First: The "working capital", which was intended to represent the amount necessary to run the mine between production and sales. As returned it equals nearly four months' expenses, and may be assumed as a low average.

Second: The "plant" means all machinery, improvements, personal property (not supplies), animals, fixtures, etc. An estimate of this should be based on actual values, not cost, and should exclude all antiquated and idle machinery. The footing in the table is believed to be a very conservative estimate.

Third: "Real estate," as explained in the bulletins of iron ore and anthracite coal, means the mine itself as a mineral producer. Its value depends, of course, on the average price of copper during a term of years, and on the f reasonable expectation of productive life for each mine.

These three items make up all the substantial actual property of the industry, as it existed June 1, 1880, and an estimate of them for each mine is much more likely to approximate to true values than a mere return of share capital. The market value of the share capital has been, of course, used as a check whenever it was based on ability to pay dividends. The values sought for were not original cost nor selling price, but actual worth based on ability to contribute to the net industrial income of the country at large. Our aim has been to avoid overestimates, and to adopt a system that could be used for future comparisons for the purpose of illustrating industrial progress.

The "working capital" of the establishments is represented by copper on hand at the mines, or in transit to market. If it is carried after that point by the mines, they assume the character of metal brokers. We wish to restrict our report to industrial production simply. Therefore we assume that what we call "working capital" or

a Prepared for Census Bulletin No. 264. The figures have been corrected where necessary to make them agree with the final results.

a that portion which is not invested, but advanced out of production, is not jeopardized except by the inconsiderable fluctuations of price during a period of four months. Consequently it may be assumed that it need not earn more than 5 per cent. per annum. The "plant", however, like all mining plant, should earn not less than 30 per cent. to make good average expenditures for deterioration and replacement.

After deducting the proper sum for these two permanent charges, the net income of the copper mines of the eastern district is a little over two and a half millions of dollars. Assuming this to be paid annually, and taking 5 per cent. as the ruling rate of interest, the value of the real estate as reported would indicate an average expectation of a productive life of fifteen years for the copper mines on it; an expectation which it is believed that their average condition justifies. The fact that the income is paid at intervals shorter than one year shortens the b expectation considerably; but without taking this into consideration, it is evident that we have not fallen into the error of exaggerating the present value of the copper-producing property.

It requires, as will be seen by the tables, 62½ cents capital to produce a pound of copper per year. Of this, 77.5 per cent. represents the land (though the original outlay may have been much less); 18.40 per cent. of it is invested in the "plant", and 4.20 per cent. of it is required for wages advanced and supplies carried in the ordinary course of business. These averages apply to the industry as a whole, and of course vary greatly for different mines. Labor obtains about one-third of the value of the product, and nearly one-sixth is expended in the necessary mine supplies. The value of the yearly product is nearly 28 per cent. of the total capital.

The production of the extreme western states and territories (Colorado, Arizona, Idaho, California, Alaska, c Montana, Nevada, and New Mexico) is not included in the table. As far as received the production is 5,410,546 pounds, or 10.73 per cent. of the amount produced in the eastern district. Details from them will be given in the final report.(*a*)

Eleven new mines in Maine, Maryland, and New Hampshire report the employment of 162 men, the payment of $31,995 for wages, and $7,650 for material consumed. They have spent $658,470 for machinery, dead work, etc., but have produced no ingot copper. The returns from this class of mines are excluded from the tables, which are restricted to establishments of productive industry.(*b*)

The acknowledgments of the office are due to the agents of the copper mines throughout the country, especially to those of the Lake Superior district, for the promptness and courtesy with which they responded to our calls for information. Had the census year corresponded with the business year terminating January 1, the d questions could have been answered with much greater ease.

Table 49 (p. 798) contains the principal statistics of the copper-mining industry of the United States in the region east of the 100th meridian, during the census year ending May 31, 1880:

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a See p. 800. *b* See pp. 798, 799, note, and lower table.

STATISTICS

OF THE

PRODUCTION OF LEAD AND ZINC ORE EAST OF THE 100TH MERIDIAN IN THE CENSUS YEAR.

TABLE 51.—*Production of lead and zinc ore east of the 100th meridian, by counties.*

State.	County.	Number of mines.	CAPITAL.				LABOR.								WAGES.
			Total.	Real estate, buildings, and lands.	Plant, equipment, and animals.	Working capital.	Total employés.	Above ground.		Below ground.		Administrative force.	Miners.	Laborers.	Total amount paid.
								Men.	Boys.	Men.	Boys.				
Grand total		206	$7,442,983	$4,556,763	$2,138,155	$748,065	7,483	3,025	105	4,298	55	420	4,693	2,370	$2,640,265
Illinois	Jo Daviess	7	75,510	40,860	28,500	6,150	164	41		123		3	121	40	$47,502
Iowa	Clayton	1	185	150	10	25	2			2			2		70
Do	Dubuque	10	16,019	6,809	5,965	3,245	55	12	1	41	1	2	43	10	9,401
Kansas	Cherokee	12	238,493	86,461	44,832	107,200	1,674	600		1,074		21	1,156	497	259,306
Maryland	Frederick	1	6,500	5,000	1,000	500	15	4		10	1	2	10	3	5,000
Missouri	Christian	1	5,375	1,875	3,000	500	60	40		20		20	20	20	12,096
Do	Cole	2	575	400	100	75	6			6		1	5		868
Do	Dade	3	5,379	729	1,950	2,700	115	27		88		21	87	7	6,547
Do	Franklin	2	176,000	60,000	101,000	15,000	111	77	1	33		13	38	60	41,000
Do	Greene	3	11,730	5,180	1,700	4,850	204	64		140		4	136	64	7,670
Do	Jasper	29	1,155,540	540,757	365,183	249,600	2,427	1,050		1,377		219	1,466	742	1,503,836
Do	Jefferson	4	36,682	21,400	15,012	270	24	7		17		1	21	2	1,496
Do	Madison	2	1,098,797	925,000	141,797	32,000	165	57	3	105		11	105	49	110,063
Do	Moniteau	1	258	200	8	50	2	2					2		
Do	Morgan	4	1,766	1,350	96	320	11	2		9		1	10		530
Do	Newton	1	118,000	63,000	40,000	15,000	442	187		255		2	340	100	117,907
Do	Saint François	3	843,140	288,000	459,140	96,000	517	259	8	230	20	30	186	301	172,032
Do	Washington	14	634,862	442,225	138,487	54,150	419	176	9	233	1	18	307	94	55,754
Do	Wright	2	1,950	1,125	200	625	19		9	10		1	13	5	4,455
New Jersey	Sussex	5	817,000	664,000	86,000	67,000	187	81	7	99		9	149	29	64,729
Pennsylvania	Lehigh	2	1,752,000	1,066,000	650,000	36,000	218	94	32	92		14	52	152	78,100
Tennessee	Claiborne	1	7,150	5,000	150	2,000	35	35				3	22	10	6,000
Do	Jefferson	2	10,700	6,500	2,100	2,100	45	41	4			3	24	18	4,188
Do	Knox	1	75,000	70,000	2,000	3,000	24	24				4	20		2,000
Do	Union	1	30,000	15,000	5,000	10,000	38	21	2	15		1	25	12	17,000
Virginia	Wythe	2	215,700	170,500	25,200	20,000	138	43	15	60	20	6	46	86	27,875
Wisconsin	Grant	33	28,602	19,627	5,290	3,685	92	30	1	56	5	1	71	20	11,540
Do	Iowa	37	55,081	33,631	10,530	10,920	197	37	12	141	7	6	154	37	53,607
Do	La Fayette	20	24,989	15,984	3,905	5,100	77	14	1	62		3	62	12	19,693

State.	County.	MATERIALS.			PRODUCTS.			ANIMALS.			
		Total value of all materials.	Value of explosives.	Value of other materials.	Lead ore.	Zinc ore.	Other ores.	Horses.		Mules.	
								Number.	Value.	Number.	Value.
					Tons.	*Tons.*	*Tons.*				
Grand total		$331,970	$145,656	$186,314	53,140	123,868	10,194	136	$10,870	118	$11,215
Illinois	Jo Daviess	5,422	643	4,779	772	3,000		2	100		
Iowa	Clayton				1						
Do	Dubuque	5,297	118	5,179	383			4	300		
Kansas	Cherokee	64,260	51,674	12,586	10,681	7,248		26	1,950	8	900
Maryland	Frederick	400	100	300		672	2				
Missouri	Christian	1,000	500	500	432						
Do	Cole	55	15	40	30						
Do	Dade	1,450	825	625	48	251					
Do	Franklin	7,300	825	6,475	215			9	870		
Do	Greene	3,775	3,135	640	636	43		1	85		
Do	Jasper	76,386	39,604	36,782	10,878	21,304		23	2,625	18	2,150
Do	Jefferson	55	22	33	56						
Do	Madison	14,582	4,120	10,462	3,581			4	300	2	160
Do	Moniteau	5		5	3						
Do	Morgan	70	30	40	64						
Do	Newton	26,000	10,000	16,000	1,289	9,550					
Do	Saint François	56,645	16,794	39,851	9,844	2,239		10	675	31	2,540
Do	Washington	7,080	793	6,287	1,185	606		10	650	35	3,450
Do	Wright	129	90	39	54	351					
New Jersey	Sussex	15,292	2,694	12,598		39,381	10,192	5	500	2	250
Pennsylvania	Lehigh	30,040	8,750	21,290		20,459		11	900	8	775
Tennessee	Claiborne	500	75	425		1,120					
Do	Jefferson	508	15	493	60	115		6	400		
Do	Knox	200	50	150		224					
Do	Union	4,500	1,500	3,000		2,240		2	200	5	500
Virginia	Wythe	2,700	1,004	1,696	11,200	10,448		7	360	8	430
Wisconsin	Grant	1,226	358	868	667	220		4	185		
Do	Iowa	4,731	1,466	3,265	481	3,975		8	550	1	60
Do	La Fayette	2,362	456	1,906	580	422		4	220		

TABLE 51.—*Production of lead and zinc ore east of the 100th meridian, by counties*—Continued.

State.	County.	STEAM-POWER. Engines. Number.	Engines. Value.	Engines. Horse-power.	Boilers. Number.	Boilers. Value.	Boilers. Horse-power.	MACHINERY. Hoisting-machines, number.	Pumps and pumping-machines. Number.	Pumps and pumping-machines. Value.	Total number machines of every kind.	Total value of all machines.	Remarks.
Grand total		167	$462,822	6,739	209	$150,706	6,797	503	222	$97,941	1,479	$476,295	
Illinois	Jo Daviess	3	6,000	240	4	5,700	300	15	5	6,475	31	22,245	The remarks for Wisconsin apply here also. The following figures are taken from the Lead and Zinc Smelting and Reduction Works schedules: Illinois ores, received by reduction-works during census year: Galana, 2,678,239 pounds; zinc (blende), 176,400 pounds; zinc (silicate), 14,206,000 pounds.
Iowa	Clayton												The remarks on the grand total sheet for Wisconsin apply here also. The following figures are taken from the Lead and Zinc Smelting and Reduction Works' schedules: Iron ores received by reduction-works during the census year: Galena, 1,990,587 pounds; zinc (silicate), 72,510 pounds.
Do	Dubuque	1	3,600	25	3	800	50	12	4	715	15	5,235	
Kansas	Cherokee	14	4,900	268	12	4,750	285	115	18		226	33,210	The remarks for Missouri (lead and zinc) apply here also. The following figures are taken from the Lead and Zinc Smelting and Reduction Works' schedules: Kansas ores received by reduction-works during census year: Galena, 20,925,106 pounds; lead (carbonate), 1,340 pounds; zinc (blende), 5,965,600 pounds.
Maryland	Frederick								1	30	1	30	
Missouri	Christian												These statistics, as well as those of lead and zinc for Kansas, were collected by Professor W. B. Potter, of Saint Louis.
Do	Cole										8	23	
Do	Dade	1	200	10	1	200	10				1	400	*Wages and time:* The average monthly earnings, as ascertained by dividing wages by product of "employés" and months worked, show that wages may run from $50 or more to nothing a day. Professor Potter, in explaining this, states that the time returned includes time spent prospecting, and that men are paid by the 1,000 pounds of ore.
Do	Franklin	4	8,000	73	4	3,050	175	9	6	5,000	25	21,600	
Do	Greene							5			5	440	
Do	Jasper	71	51,510	1,465	76	45,406	1,787	102	109	55,324	450	184,357	
Do	Jefferson	2	800	74	2	600	60	14	2	500	17	2,063	
Do	Madison	7	3,372	80	8	5,100	166	7	13	4,747	63	27,219	The following figures are taken from the Lead and Zinc Smelting and Reduction Works' schedules, and show the Missouri ores received during census year: Galena, 29,541,345 pounds; lead (carbonate), 314,889 pounds; zinc (blende), 49,051,415 pounds; zinc (carbonate), 7,961,080 pounds; zinc (silicate), 50,637,560 pounds; besides slag for white-lead from Missouri furnaces, 3,993,106 pounds.
Do	Moniteau										1	3	
Do	Morgan										5	15	
Do	Newton	17	6,900	198	22	9,075	287	98	22	8,500	165	29,425	
Do	Saint François	12	12,650	797	21	14,300	101	31	18	6,710	196	70,469	
Do	Washington	4	1,640	108	5	3,600	116		1	550	78	6,151	*Deficiencies:* No returns could be obtained from the "Broadway Diggings", at Joplin. The mines are operated by a number of parties, and no records are kept.
Do	Wright												
New Jersey	Sussex	10	7,250	170	11	4,825	230	11	6	4,700	20	33,000	
Pennsylvania	Lehigh	15	353,000	3,160	34	51,100	3,160	3	4	3,000	44	31,100	
Tennessee	Claiborne												The following figures are taken from Smelting and Reduction Works' schedules (Lumaghi Zinc-Works, Collinsville, Madison, Illinois): Carbonate of zinc received from Tennessee during census year, 306,000 pounds.
Do	Jefferson	1	400	8	1	400	8				2	1,300	
Do	Knox												
Do	Union	2	1,500	26	2	1,000	26						
Virginia	Wythe								3	75			
Wisconsin	Grant							24	1	400	28	840	Capital in real estate, when not returned, has been estimated as equal to the royalty on three full years' production at the rate of the monthly production during the census year.
Do	Iowa	1	300	10	1	400	10	33	2	115	43	3,600	
Do	La Fayette	2	800	27	2	400	26	24	7	1,100	55	3,570	Working capital estimated as equal to "labor" and "materials" for two months. Wages represent in many cases the value of labor and the profit in the business, as the mines are generally operated by two or three miners working in a partnership, and doing all the work themselves. Materials include powder, lumber, and feed, fuel, etc. The following figures are taken from the Lead and Zinc Smelting and Reduction Works' schedules, and show the Wisconsin ores received during census year: Galena, 7,950,069 pounds; zinc (blende), 468,000 pounds; zinc (carbonate), 637,340 pounds; zinc (silcate), 751,930 pounds.

TABLE 52.—*Production of lead and zinc ore east of the 100th meridian, by states.*

States.	CAPITAL.					LABOR.								WAGES.
	Number of mines.	Total.	Real estate, buildings, and land.	Plant, equipment, and animals.	Working capital.	Total employés.	Above ground.		Below ground.		Administrative force.	Miners.	Laborers.	Total amount paid.
							Men.	Boys.	Men.	Boys.				
Grand total	206	$7,442,983	$4,556,763	$2,138,155	$748,065	7,483	3,625	105	4,298	55	420	4,693	2,370	$2,640,265
Illinois	7	75,510	40,860	28,500	6,150	164	41	.....	123	.....	3	121	40	47,502
Iowa	11	16,204	6,959	5,975	3,270	57	12	1	43	1	2	45	10	9,471
Kansas	12	238,493	86,461	44,832	107,200	1,674	600	.....	1,074	.....	21	1,156	497	259,306
Maryland	1	6,500	5,000	1,000	500	15	4	.....	10	1	2	10	3	5,000
Missouri	71	4,090,054	2,351,241	1,267,673	471,140	4,522	1,948	30	2,523	21	342	2,736	1,444	2,034,254
New Jersey	5	817,000	664,000	86,000	67,000	187	81	7	99	.....	9	149	29	64,729
Pennsylvania	2	1,752,000	1,066,000	650,000	36,000	218	94	32	92	.....	14	52	152	78,100
Tennessee	5	122,850	96,500	9,250	17,100	142	121	6	15	.....	11	91	40	29,188
Virginia	2	215,700	170,500	25,200	20,000	138	43	15	60	20	6	46	86	27,875
Wisconsin	90	108,672	69,242	19,725	19,705	366	81	14	259	12	10	287	69	84,840

States.	MATERIALS.			PRODUCTS.							ANIMALS.			
	Total value of all materials.	Value of explosives.	Value of other materials.	Lead ore.	Value.	Zinc ore.	Value.	Other ores.	Value.	Total value of all products.	Horses.		Mules.	
											Number.	Value.	Number.	Value.
				Tons.		*Tons.*		*Tons.*						
Grand total	$331,970	$145,656	$186,314	53,140	$2,102,948	123,868	$1,734,213	10,194	.....	.....	136	$10,870	118	$11,215
Illinois	5,422	643	4,779	772	30,200	3,000	39,000	.....	.....	.....	2	100	.....	.....
Iowa	5,297	118	5,179	384	19,172	.....	.....	.....	.....	.....	4	300	.....	.....
Kansas	64,260	51,674	12,586	10,681	460,980	7,248	131,169	.....	.....	.....	26	1,950	8	900
Maryland	400	100	300	.....	.....	672	7,200	2	.....	.....	.....	.....	.....	.....
Missouri	194,532	76,753	117,779	28,315	1,478,571	34,344	599,373	.....	.....	.....	57	5,205	86	8,300
New Jersey	15,292	2,694	12,598	.....	.....	39,381	451,070	10,192	.....	.....	5	500	2	250
Pennsylvania	30,040	8,750	21,290	.....	.....	20,459	394,568	.....	.....	.....	11	900	8	775
Tennessee	5,708	1,640	4,068	60	2,500	3,699	23,145	.....	.....	.....	8	600	5	500
Virginia	2,700	1,004	1,696	11,200	33,000	10,448	24,126	.....	.....	.....	7	360	8	430
Wisconsin	8,319	2,280	6,039	1,728	78,525	4,617	64,562	.....	.....	.....	16	955	1	60

States.	STEAM-POWER.						MACHINERY.				
	Engines.			Boilers.			Number of hoisting-machines.	Pumps and pumping-engines.		Total number of machines of every kind.	Total value of all machines.
	Number.	Value.	Horse-power.	Number.	Value.	Horse-power.		Number.	Value.		
Grand total	167	$462,822	6,739	209	$150,706	6,797	503	222	$97,941	1,479	$476,295
Illinois	3	6,000	240	4	5,700	300	15	5	6,475	31	22,245
Iowa	1	3,600	25	3	800	50	12	4	715	15	5,235
Kansas	14	4,900	268	12	4,750	285	115	18	.....	226	33,210
Maryland	.....	.....	.....	.....	.....	.....	.....	1	30	1	30
Missouri	118	85,072	2,805	139	81,331	2,702	266	171	81,331	1,014	342,165
New Jersey	10	7,250	170	11	4,825	230	11	6	4,700	20	38,000
Pennsylvania	15	353,000	3,160	34	51,100	3,160	3	4	3,000	44	31,100
Tennessee	3	1,900	34	3	1,400	34	.....	.....	.....	2	1,300
Virginia	.....	.....	.....	.....	.....	.....	.....	3	75	.....	.....
Wisconsin	3	1,100	37	3	800	36	81	10	1,615	126	8,010

THE INDUSTRIES OF THE BASE METALS

(LEAD, ZINC, AND COPPER)

IN THE CENSUS YEAR.

THE INDUSTRIES OF THE BASE METALS (LEAD, ZINC, AND COPPER).

By George H. Eldridge. c

To present as nearly as possible a correct idea of the metallurgy of the base metals throughout the United States, there should be given a concise description of the methods pursued in the treatment of their ores, together with a detailed statement of the conditions under which they are conducted; but, though the data are at hand, time necessary for such a lengthy discussion is lacking, and, therefore, nothing beyond a complete statistical representation of the several industries, with such explanatory notes as may be necessary, will be attempted.

As attesting the value of the tables, it should be stated that their compilation is based on a thorough personal investigation of each of the processes in use, such investigations, with a few unavoidable and unimportant exceptions, having been carried to every establishment east of the 100th meridian. In the few instances where a personal visit could not be paid, the essential data were obtained by letter. d

Before passing to an inspection of the tables, it should be understood that throughout this entire article all statistics are based on the ores actually smelted between June 1, 1879, and May 31, 1880; that the materials, hours of work, wages, etc., are the amounts consumed in extracting the product given from this ore; and that no connection exists between smelting and mining operations, except in a very broad way.

Concerning the arrangement of the tables the forms offered have been deemed the most expedient, since the information gained has been given in strict confidence, and there is a necessity of guarding against any arrangement that would tend to give publicity, either directly or indirectly, to individual operations.

In lead smelting, the arrangement by states has been very closely adhered to, but Virginia and Tennessee, each possessing one smelter, were placed together under "South and east of the Ohio river". Under zinc the "Eastern" works comprise those in the states of New Jersey, Pennsylvania, and Virginia, which, excepting the e Bertha Zinc works in Virginia, have also an additional product of zinc oxide. Respecting these, the facts given relate solely to their metallurgical work, and no account has been taken of the supplies (excepting ore consumed), wages, or capital employed in the production of zinc oxide. This product has been given as showing the outcome of the ore worked up, and the ore was given as being of interest in connection with the other ores of the same kind consumed in purely metallurgical processes. The copper works of the "East" comprise those of Vermont, eastern Pennsylvania, Maryland, and North Carolina, none smelting native copper. The two smelters in western Pennsylvania and Michigan comprise the "Western works", both working on native copper alone.

The smelting and refining works comprise those in Omaha, Chicago, Pittsburgh, Saint Louis, and Newark, and are necessarily brought under the general designation of "United States, east of the 100th meridian".

Nickel would have been included in the production of the base metals, but for the fact that there is only one f producer of the metal in the United States, though a large one and well worthy of notice.

THE LEAD INDUSTRY.

Under this head are brought all those establishments concerned in the working of lead ores, for the product "lead" and any slight accessory "products of nickel, cobalt, and copper" that may be obtained at the same time. They are representative of four different processes—the Corinthian, the Scotch hearth, the blast furnace, and the Flintshire, their statistics being presented under their respective heads in Table 54.

TABLE 53.—*Lead-smelting works, by states, etc.*

	UPPER MISSISSIPPI REGION.							
	Total.		Illinois.		Iowa.		Wisconsin.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Number of counties	5		1		1		3	
Number of establishments	22		5		3		14	
MATERIALS.								
Fuel used in reducing ores, etc.:								
Coke ... pounds	200,800	$961	26,000	$121	26,400	$151	148,400	$689
Charcoal ... bushels	4,092	468	805	161	1,030	122	2,257	245
Wood ... cords	1,462	5,927	155	790	130	685	1,177	4,452
Fuel used for power:								
Coal ... pounds	19,000	43			19,000	43		
Wood ... cords	22	79					22	79
Other supplies:								
Finished materials ... value		2,628		450		610		1,568
Total value of all supplies		10,106		1,462		1,611		7,033
Ores reduced:								
Galena ... pounds	12,098,895	323,164	2,457,404	69,066	1,987,582	54,752	7,653,909	199,346
LABOR.								
Skilled laborers ... No.	32		7		3		22	
Days employed ... No.	5,075		866		672		3,537	
Net wages		9,910		1,349		847		7,714
Ordinary laborers ... No.	42		8		7		27	
Days employed ... No.	8,055		1,454		1,624		4,977	
Net wages		10,106		1,658		2,059		6,389
Total wages		20,016		3,007		2,906		14,103
PRODUCTION.								
Pig-lead ... pounds	8,182,039	383,511	1,685,797	79,514	1,394,824	63,140	5,101,418	240,857
CAPITAL.								
Capital, fixed		63,310		16,200		15,300		31,810
Capital, floating		91,300		18,000		10,000		63,300

TABLE 54.—*Lead smelting works, by states, etc.*—Continued.

	LOWER MISSISSIPPI REGION.						SOUTH AND EAST OF OHIO RIVER REGION.	
	Total.		Kansas.		Missouri.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Number of counties	11		1		10		2	
Number of establishments	33		3		30		2	
MATERIALS.								
Fuel used in reducing ores, etc.:								
Coal ... pounds	2,476,400	$7,446			2,476,400	$7,446		
Coke ... pounds	6,338,860	28,608			6,338,860	28,608		
Charcoal ... bushels	134,599	10,930	30,588	$2,559	104,011	8,371	10,000	$500
Wood ... cords	11,143	21,171	68	122	11,075	21,049	956	573
Fuel used for power:								
Coal ... pounds	9,105,542	9,570	815,542	1,020	8,290,000	8,550		
Wood ... cords	11,148	22,182			11,148	22,182	19	38
Other supplies:								
Fluxes ... value		19,993		612		19,381		
Finished materials ... value		26,917		1,964		24,953		600
Total value of all supplies		146,817		6,277		140,540		1,711
Ores reduced:								
Galena ... pounds	79,624,976	1,962,558	9,176,500	234,056	70,448,476	1,728,502	1,912,000	27,303
Dry bone ... pounds	82,200	1,009			82,200	1,009		
Total of all ores of each metal ... pounds	79,707,176	1,963,567	9,176,500	234,056	70,530,676	1,729,511	1,912,000	27,303
LABOR.								
Skilled laborers ... No.	353		40		313		4	
Days employed ... No.	79,333		6,981		72,352		750	
Net wages		153,826		13,931		139,895		1,125
Ordinary laborers ... No.	290		9		281		5	
Days employed ... No.	74,207		1,326		72,881		1,050	
Net wages		98,401		2,159		96,242		1,050
Total wages		252,227		16,090		236,137		2,175
STAFF.								
Number	27		4		23			
Total salaries		37,468		4,720		32,748		
PRODUCTION.								
Pig-lead ... pounds	57,425,151	2,759,424	6,365,551	295,044	51,059,600	2,464,380	886,868	35,500
Nickel and cobalt mattes ... pounds	38,293	5,514			38,293	5,514		
White-lead ... pounds	2,156,100	86,244			2,156,100	86,244		
Blue-lead ... pounds	348,489	12,197			348,489	12,197		
Total value of product		2,863,379		295,044		2,568,335		35,500
CAPITAL.								
Capital, fixed		802,039		14,332		787,707		10,000
Capital, floating		333,945		30,000		303,945		10,000

a TABLE 54.—*Lead-smelting works, by states, etc.*—Continued.

GRAND TOTAL.

	Quantity.	Value.
Number of counties	18	
Number of establishments	57	
MATERIALS.		
Fuel used in reducing ores, etc.:		
Coal ... pounds	2,476,400	$7,446
Coke ... pounds	6,539,660	29,569
Charcoal ... bushels	148,691	11,898
Wood ... cords	13,561	27,671
Fuel used for power:		
Coal ... pounds	9,124,542	9,613
Wood ... cords	11,189	22,299
Other supplies:		
Fluxes ... value		19,993
Finished materials ... value		30,145
Total value of all supplies		158,634
Ores reduced:		
Galena ... pounds	93,635,871	2,313,025
Dry bone ... pounds	82,200	1,009
Total of all ores of each metal ... pounds	93,718,071	2,314,034

	Quantity.	Value.
LABOR.		
Skilled laborers ... No.	389	
Days employed ... No.	85,158	
Net wages		$164,861
Ordinary laborers ... No.	337	
Days employed ... No.	83,312	
Net wages		109,557
Total wages		274,418
STAFF.		
Number	27	
Total salaries		37,468
PRODUCTION.		
Pig-lead ... pounds	66,494,058	3,178,435
Nickel and cobalt mattes ... pounds	38,293	5,514
White-lead ... pounds	2,156,100	86,244
Blue-lead ... pounds	348,489	12,197
Total value of product		3,282,390
CAPITAL.		
Capital, fixed		875,349
Capital, floating		435,245

The figures here presented consist of many widely varying components which must be briefly noticed.

The coal, both for power and for smelting, is supplied by two fields, 8,920,982 pounds by the Kansas, and 2,679,960 pounds by the Illinois field, chiefly the Big Muddy.(*a*)

The prices of the coals at the furnaces were: For the Western Missouri district, $1 90 per ton, the Kansas
d coal-field being distant only 35 miles, while for the Eastern Missouri region the average price was $6 23½ per ton, the field being distant, by transportation routes (rail), 130 miles, though in a direct line only 40 or 50 miles. By comparing the price of Kansas coal, as above stated, with that in the bituminous coal table, there appears the somewhat strange fact that the price at the furnaces, 35 miles distant (via rail), is less than that at the shaft. In explanation, it should be noted, on the one hand, that the figures in the coal table represent the average price for Kansas coal for the entire field as determined by mining returns, but, on the other hand, from personal inquiries among the smelters, it is learned that their coal can be purchased in large quantities at a certain mine for 80 cents to $1 12½ per ton, the latter being nearer the usual price, the former exceptional. In the eastern part of the state the railroads are apparently reaping the chief benefit, the price of Illinois coal averaging $1 44 at the mine and $6 23½ at the furnaces, while the distance carried is only about four times as great as in the west.

e No special notice need be taken of the very insignificent amount consumed by the Iowa smelters.

The sources of coke were four; Cincinnati, Illinois, Georgia, and Connellsville, furnishing as follows:

Locality.	Quantity.	Percentage.
	Pounds.	
Cincinnati	22,000	00.3
Illinois	2,460,500	37.6
Georgia	1,607,160	24.6
Connellsville	2,450,000	37.5
Total	6,539,660	100.0

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The first three quantities went to eastern Missouri, while the Connellsville coke was distributed over the entire area, 92 per cent. of it, however, going to southwest Missouri.

We will not compare the prices, as, owing to the varying distances and freights, it would signify nothing.

The charcoal was invariably made in the vicinity of the works using it, and ranged from 5 to 10 cents per bushel in Missouri, and from 10 to 15 cents in the Upper Mississippi district.

a The relative percentages of these (77 and 23, respectively, of the whole amount) have widely changed since the census year, owing to the gradual substitution of coal for wood by the larger Eastern Missouri works, the additional supply being drawn from the Illinois field.

Wood is also found in the immediate vicinity of the furnaces, and where the Corinthian process is in use will a undoubtedly continue to supply all demands of the smelters, as they usually work in a desultory manner, lying idle both during the months devoted to agriculture, and at other times, whenever there may be a lack of "mineral." The drain upon the forests by the above class of smelters is light, requiring, as they do, no power and no large furnaces, the excessive drain being made by the larger works in roasting ores, and running their heavy engines and the machinery of their dressing-works. At the time of visiting eastern Missouri, a drain of about 100 cords per day was made by the large companies alone, but as mineral fuel is fast supplanting vegetable, within a very short time the annual consumption in this locality will probably be lessened by at least 15,000 cords.

It was found impossible to present a more detailed statement of "other supplies" with any reliable approach to the truth, since the supplies comprising this column—iron, wrought and cast, fire-brick, oil for various uses, b fluxes of various kinds, etc.—were not only usually accounted for in a general way only, but, moreover, those purchased in one year were largely consumed in another; consequently, to present a comparable view, averages at each of the works were taken, based upon the amount of product turned out during the census year.

Quantities of lime, too small to note, were used in each of the states, but the only localities employing fluxes to an appreciable degree were those of Missouri and Kansas. The tabular figures would be distributed thus:

	Quantity.	Value.
Iron ore.....tons..	1,500	$14,558
Limestone.....do...	293	316
Fluor spar.....do...	130	1,548
Lime.....bushels..	13,496	2,706
Sand .....tons..	1,000	865

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The value of sand is purely arbitrary. It will at once be seen by what class of smelters the different fluxes are used.

Ores reduced.—Possibly a more appropriate and representative term than "ore" would be "mineral", the name by which the raw material is known, as it goes to the furnace in its prepared state. It is this to which the figures in the tables refer, and by it a more satisfactory comparison between states can be made, inasmuch as a common standard, "mineral" yielding practically from 60 to 75 per cent. of lead, is obtained. This mineral comes from d two classes of ore—that requiring only hand dressing and washing, which forms 73 per cent. of the total amount, and that containing only about 6 per cent. of galena, and requiring the aid of machinery to bring it to the required standard, which constitutes the other 27 per cent. The former has a general distribution over the entire field, and is smelted in air-furnaces and Scotch hearths, while the latter class occurs in only two localities, both in eastern Missouri, and is entirely smelted by three concerns, the blast and Flintshire furnaces being used in its reduction.

The values of the year's purchases ranged from $13 to $30 per 1,000 pounds, the predominating figures, as shown in the schedule, being $27. Aside from this, and computed from the figures expressed in the table, the average price for the several states would be: Illinois, $28 11; Iowa, $27 54; Wisconsin, $26 04; average for the region being $26 71. Kansas, $25 50; Missouri, $24 53; average for the region being $24 65. East, $14 28.

In the first three states, while the purchases are not based on a sliding-scale, they are, nevertheless, somewhat governed by the price of "pig-lead" in Chicago, as, for instance, when lead is worth $4 37 per 100 pounds in e Chicago, mineral brings about $25 per 1,000, but the variation from this is not proportionate. Usually, however, the prices fixed are at sight of ore at the mouth of the mine-shaft. In Missouri and Kansas, on the other hand, a closer adherence to an established basis is practiced. In the southwest section it is as follows: For mineral produced on company land, $25 per 1,000 pounds net, at the mine, when pig-lead in Saint Louis is worth 7 cents per pound, and varying in proportion. For "neutral mineral" the price is not regulated as above, but payment is made at sight, at the mouth of the shaft, at the price agreed on. The smelting company transports.

In eastern Missouri purchases are based on Saint Louis prices, but by a little different arrangement, viz: For private mineral the market value of 500 pounds of lead is given for 1,000 pounds net of mineral; for public mineral, which corresponds to the neutral of western Missouri, the value of 600 pounds of lead is given for 1,000 pounds of f mineral. On private mineral the less price covers royalty, whereas, when purchased from public lands, the miner must pay the royalty after receiving his due from the smelter. In all cases the smelter does all the hauling. This gives a concise idea of the general manner in which purchases are made in the field. In southwestern Missouri the price is at times a little influenced by a price given by one company in advance of the current market value.

Attention is called to a difference of 8½ per cent. between the lead ores actually smelted and those returned on the mining schedules, the former being in excess 4,023 tons. Referring to the respective tables, and regarding Missouri and Kansas as one region, and Illinois, Iowa, and Wisconsin as another, it will be observed that in the former the returns of the smelters exceed the mining returns only 857 tons, or 2 per cent. of the entire amount smelted. This is due to the fact that while smelting furnaces are easily discovered, it is quite the contrary with mines worked by two or three men each.

a Between the two returns of the second region is a large difference of 3,166 tons, or a little over 50 per cent. of the total smelters' returns. The same difficulty regarding obscure mines as was met with in the southwestern region exists here in a much greater degree. For this reason the return of the smelting operations is more nearly correct as to the amounts of ores mined. (*a*)

Labor.—The division of labor into skilled and ordinary has been made largely upon a basis of wages paid, rather than entirely upon the actual quality of mechanics' or smelters' work. Had this latter mode of division been carried out the number of "skilled" laborers would have been reduced to about 100, and the ordinary laborers would have been correspondingly increased. When considered in conjunction with the labor of all trades in the United States, undoubtedly this last method should be adopted; but in the consideration of lead-smelting b alone, the method of division adopted seems the more appropriate, for while the quality of work may not reach the standard of the "skilled" workman in many trades, there is, nevertheless, not only a wide difference in most cases in the pay, but as well in the degree of responsibility. This has influenced likewise the daily wages earned by each of the two classes, and perhaps no better insight into the character of labor and wages can be gained than by the inspection of the average wages per day given herewith:

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Region.	Skilled labor.	Ordinary labor.	Percentage of per diem wages for skilled labor paid for unskilled labor.
Illinois	$1 56	$1 14	73
Iowa	1 27	1 26	100
Wisconsin	2 18	1 28	59
Kansas	1 99	1 63	82
Missouri	1 93	1 32	68
South and east of Ohio river	1 50	1 00	67
Average	1 93	1 31	68

It is observed that for the entire country the day's wages for "ordinary" labor averages 68 per cent. of that for skilled labor.

d Missouri, where smelting operations are conducted on the most firmly-established basis, and which wields the greatest influence both in the number of laborers and in the methods of treatment pursued, is found to agree most closely with this ratio; south and east of the Ohio river coming next. Kansas would naturally vary from it, for not only is the average made from few (three) establishments working side by side, but also the method of reducing ores is uniform, being the Scotch hearth. In Wisconsin the gap between ordinary and skilled labor appears greatest. By the schedule it would seem that the smelter for the same class of work received from $1 to $3 50 per day, and the only manner in which this wide variation of payment for the same work can be accounted for, is the scarcity of responsible "skilled" labor in a certain district, for the excessively high wages are paid in only one locality. "Ordinary" labor, on the other hand, is to be had with much greater ease. In Iowa, strictly speaking, no division between "skilled" and unskilled labor should be made, unless that one man was nominally held more e responsible than the other. In Illinois the conditions are somewhat similar to those of Kansas.

As to the kinds of labor, it may be noted that the dressing and smelting of lead ores require three classes, the mechanic, the smelter, and the millman, the skilled of one class receiving about the same as those of another class. The millman is employed only in Missouri, where dressing-works exist, while the mechanic and the smelter have a universal distribution. Except in the case of the large companies necessarily requiring dressing-works on account of the very low grade of ore used, the preliminary treatment of the ore consists merely in a hand-sorting, and subsequent washing of its dirt by means of hand-jigs placed over small streams, which operations are usually performed by the miner, before sales, but sometimes by the smelter, who then deducts a certain amount from what would otherwise be paid to the miner.

f As to the relative proportion of "skilled" to ordinary labor, no definite statement can be made for the arrangement by states, this depending entirely upon the kind of processes and number of each employed, and the proportion existing between these two divisions in any state would be entirely changed by a change in the mode of treatment.

a In addition to the figures for ore received and product obtained, together with their respective values given in the table, there is a by-product of the zinc works of Illinois (Table 59 and page 82), resulting from the working up of 680,000 pounds of mineral valued at $17,000, and amounting to 476,780 pounds of lead, valued at $19,071. As this was purely an accessory product of the zinc works, requiring but the slightest plant beyond that in regular use, and accounted for under that industry, it was considered best to bring it in after the manner adopted, instead of placing it on the tables setting forth the regular lead industry. These small amounts wield comparatively no influence over the lead tables as presented.

ACCESSORY PRODUCTS OF THE LEAD-SMELTING WORKS. a

The nickel and cobalt mattes are at present produced by three concerns in eastern Missouri, though such was not the case in the census year. This product has developed with the establishment of blast-furnaces, and will become permanent wherever the metals occur in the ore. The mattes are shipped from the United States containing from 15 to 20 per cent. of nickel and cobalt and 5 or 6 per cent. of copper. The product, white lead, has also developed within the past two or three years, and comes directly from the smelting operations in the Scotch hearth process, being manufactured from the lead fume given off in this process in combination with lead slag and carbonate ores. A portion, however, of the fume, called blue lead in distinction from the white lead, is sold direct to rubber-works. It is easily surmised from this that the other smelting-works will soon have a product additional to their b pig-lead. Indeed, such is already the case, for 4,092,120 pounds of slag have been purchased from various parties, averaging from 25 to 40 per cent. lead, and valued at $9 50 per thousand pounds. The value of the products as given in the table might, therefore, be increased by $50,160, which figures will probably be exceeded another year.

The floating capital given is that usually employed, but it varies very greatly, according to the increase or decrease of the speculative desire. The fixed capital is, on the contrary, quite regular and steady, being the value of the land (surface only), furnaces, and machinery.

The percentages of capital employed in the various states are as follows:

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Region.	Fixed.	Floating.	Total.
	Per cent.	*Per cent.*	*Per cent.*
Illinois	1.9	4.1	2.6
Iowa	1.7	2.3	1.9
Wisconsin	3.6	14.6	7.3
Kansas	1.6	6.9	3.4
Missouri	90.0	69.8	83.3
South and east of Ohio river	1.2	2.3	1.5
Total	100.0	100.0	100.0

In table No. 54 the statistics are also combined so as to show the work of the two great regions—the Upper d Mississippi, comprising Wisconsin, Illinois, and Iowa, and the Lower, comprising Missouri and Kansas, and as well, also, that south and east of the Ohio river. The very slight extent of the operations of the Upper Mississippi, as compared with those of the Lower region, is to be noted. The former's percentage of the raw material worked up in the latter locality is only 15.2, the values not admitting of comparison on account of the fluctuation in the price of lead throughout the year. The percentage of the pig-lead product of the Upper Mississippi region to that of the Lower Mississippi is 14.1, but this is diminished if we take into consideration the accessory product of the latter, nickel and cobalt matte and white lead. Again, but 11.5 per cent. of the labor employed in the Lower Mississippi district is employed in the Upper, while 8.6 per cent. expresses the percentage of the days worked in the one, compared with the days worked in the other.

This superficial method of comparison is given merely to present a little more readily and forcibly the wide e difference between the two localities, much changed from the condition of former times.

TABLE 54.—*Lead-smelting works.*

	SCOTCH HEARTH PROCESS.							
	Total.		Upper Mississippi region.		Lower Mississippi region.		South and East of Ohio River region.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
FURNACES.								
Mineral eyes	69		16		51		2	
Slag eyes	16		6		10		0	
MATERIALS.								
Fuel used in reducing ores, etc.:								
Coal ... pounds	144,560	$181			144,560	$181		
Coke ... pounds	2,394,000	14,878	122,800	$601	2,271,200	14,277		
Charcoal ... bushels	130,591	10,806	3,992	456	116,599	9,850	10,000	$500
Wood ... cords	2,895	6,919	701	3,335	1,238	3,011	956	573
Fuel used for power:								
Coal ... pounds	8,795,422	8,584	19,000	43	8,776,422	8,541		
Wood ... cords	395	676			376	638	19	38
Other supplies:								
Fluxes ... value		2,705				2,705		
Finished materials ... value		13,432		1,800		11,032		600
Total value of all supplies		58,181		6,235		50,235		1,711
Ores reduced:								
Total of all ores of each metal ... lbs	58,542,034	1,610,629	7,990,972	213,504	48,639,062	1,369,822	1,912,000	27,303
LABOR.								
Skilled laborers ... No	275		15		256		4	
Number of days employed	57,337		2,740		53,847		750	
Net wages		118,807		3,976		113,706		1,125
Ordinary laborers	120		28		87		5	
Number of days employed	26,487		5,842		19,595		1,050	
Net wages		38,005		7,015		29,940		1,050
Total wages		156,812		10,991		143,646		2,175
STAFF.								
Number of staff	15				15			
Salaries of same		18,540				18,540		
PRODUCTION.								
Pig-lead ... pounds	43,539,785	2,014,964	5,661,151	261,395	36,991,766	1,718,069	886,868	35,500
Nickel and cobalt matte ... pounds								
White lead ... pounds	2,156,100	86,244			2,156,100	86,244		
Blue lead ... pounds	348,489	12,197			348,489	12,197		
Total value of product		2,113,405		261,395		1,816,510		35,500
CAPITAL.								
Capital, fixed		395,295		46,245		339,050		10,000
Capital, floating		259,700		44,000		205,700		10,000

TABLE 54.—*Lead-smelting works*—Continued.

	AIR PROCESS.						BLAST PROCESS.		FLINTSHIRE PROCESS.	
	Total.		Upper Mississippi region.		Lower Mississippi region.		Lower Mississippi region.		Lower Mississippi region.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
FURNACES.										
Mineral eyes	22		9		13		3		3	
Slag eyes	1		1		0					
MATERIALS.										
Fuel used in reducing ores, etc.:										
Coal ... pounds							40,000	$102	2,291,840	$7,163
Coke ... pounds	78,000	$360	78,000	$360			4,067,660	14,331		
Charcoal ... bushels	100	12	100	12			18,000	1,080		
Wood ... cords	3,510	6,441	760	2,592	2,750	$3,849	5,366	10,730	1,790	3,581
Fuel used for power:										
Coal ... pounds									329,120	1,029
Wood ... cords	22	79	22	79			8,268	16,536	2,504	5,008
Other supplies:										
Fluxes ... value								15,740		1,548
Finished materials ... value		1,946		828		1,118		9,667		5,100
Total value of all supplies		8,838		3,871		4,967		68,186		23,429
Ores reduced:										
Total of all ores of each metal ... lbs	9,941,507	248,394	4,107,923	108,659	5,833,584	139,735	18,072,530	316,785	7,162,000	138,226
LABOR.										
Skilled laborers ... No	33		17		16		68		13	
Number of days employed	5,373		2,335		3,038		18,286		4,162	
Net wages		11,683		5,933		5,750		26,722		7,649
Ordinary laborers	28		14		14		156		33	
Number of days employed	5,579		2,213		3,366		40,950		10,296	
Net wages		7,920		3,090		4,830		50,006		13,626
Total wages		19,603		9,023		10,580		76,728		21,275
STAFF.										
Number of staff							10		2	
Salaries of same								13,928		5,000
PRODUCTION.										
Pig-lead ... pounds	6,537,319	310,446	2,520,888	122,116	4,016,431	188,330	12,473,514	695,099	3,943,440	157,926
Nickel and cobalt matte ... pounds							38,293	5,514		
White lead ... pounds										
Blue lead ... pounds										
Total value of product		310,446		122,116		188,330		700,613		157,926
CAPITAL.										
Capital, fixed		31,572		17,065		14,507		328,482		120,000
Capital, floating		75,545		47,300		28,245		75,000		25,000

a In explanation of many of the details of this table reference may be had to the remarks on Table 53. It is to be noticed, however, that the number of furnaces is substituted for establishments, as showing the extent of the plant in use in turning out the product. The figures of the subdivision "mineral eye" are intended to represent the furnaces engaged in smelting mineral, while the figures of the second subdivision represent the extent of plant engaged in working up the residues and slag resulting from the first treatment of mineral. The process by the Scotch hearth is nearly the only one employing this secondary treatment, since it can be done with no appreciable additional outlay for machinery, the requisite power and blast being obtained from the same source as the first treatment. On the other hand, the air-reduction process would require not only a greater outlay for a proper furnace than the other, but also power and blower; consequently, since the secondary treatment is generally not b considered profitable by the smelters using this process, the slag of these furnaces is usually thrown aside, and, if opportunity offers, is sold. Associated with the blast-furnaces, as an essential part of the plant, are one nickel furnace, one improving furnace, and eight roasting furnaces.(*a*)

Regarding the supplies consumed, the arrangement in this table gives a better idea of their distribution than that of the preceding table, and it is in part explanatory of the varying amounts consumed in three regions as well as in separate states, as shown in the first table.

The percentages of ore worked up by the various processes are, for the—

c

Process.	Per cent.
Scotch hearth	62.47
Air-furnaces	10.61
Blast	19.28
Flintshire	7.64
Total	100.00

Of the ores worked by the first process, 83.08 per cent. was smelted in the Lower Mississippi region, while but 13.65 per cent. was smelted in the Upper, the remaining 3.27 per cent. being that worked in the east. This illustrates very well the relative magnitude of this process in the three regions. The work of the air-furnaces is more equally divided between the two western regions, the percentage of ore consumed being, for the Upper Mississippi region 41.32 per cent., and for the Lower Mississippi region 58.68 per cent.

The average day's wages earned in the different processes in the various districts by skilled and by unskilled d labor are as follows:

e

Process.	Locality.	WAGES PER DAY.	
		Skilled labor.	Ordinary labor.
Scotch hearth	Upper Mississippi	$1 45	$1 29
	Lower Mississippi	2 11	1 53
	South and East of Ohio river	1 50	1 00
	Average	2 07	1 43
Air-furnace	Upper Mississippi	2 52	1 39
	Lower Mississippi	1 89	1 43
	Average	2 17	1 42
Blast	Lower Mississippi	1 46	1 22
Flintshire	Lower Mississippi	1 84	1 32

The fact that the labor of the air-furnaces is paid more than that of the Scotch hearth is due to the location, the Scotch hearths being located in the region of low wages, and the air process in the region of high wages, as previously mentioned, under the discussion of Table 53. That the skilled labor of the blast-furnaces is as low as the figures represent is due to the fact that it is not of as high a standard as that of the first two processes, for here f superintendence is more strict, larger salaries being paid for metallurgists and managers, whose duty is the immediate supervision of the operations and the laborers conducting them. The labor of the Flintshire process, on the contrary, is of a higher type than that of the blast-furnace, and more nearly approaches the labor of the other processes.

The percentage of total yield we find to be distributed thus:

Process.	Percentage.
Scotch hearth	65.5
Air-furnaces	9.8
Blast	18.8
Flintshire	5.9
Total	100.0

a From the data derived from the mining schedules of the parties owning the furnaces, it seemed proper that the Eastern works should be included among the Scotch hearths.

In addition to this, there must be taken into account the white-lead production of the Scotch hearths, and a the matte production of the blast-furnaces.

The percentages of capital employed in the processes are, for the—

Process.	Percentage.
Scotch hearth	50.0
Air-furnaces	8.2
Blast	30.7
Flintshire	11.1

These are the leading peculiarities of this table. b

TABLE 55.—*To produce one ton of lead, by states and regions.*

States.	Value of fuel.	Value of other supplies.	Total value of all supplies.	Ore used.	Total number of days.	Total wages paid, including staff.	Total capital.
				Pounds.			
Illinois	$1 20	$0 53	$1 73	2,915.07	2.75	$3 57	$40 57
Iowa	1 44	88	2 32	2,851.62	3.29	4 17	36 30
Wisconsin	2 14	61	2 75	3,000.36	3.34	5 53	37 28
Total Upper Mississippi region	1 83	64	2 47	2,957.44	3.21	4 89	37 79
Kansas	1 16	81	1 97	2,882.97	2.61	6 54	13 93
Missouri	3 77	1 74	5 51	2,762.66	5.68	10 53	42 76
Total Lower Mississippi region	3 48	1 63	5 11	2,771.17	5.34	10 08	39 49
South and East of Ohio River region	2 51	1 35	3 86	4,316.03	4.06	4 91	45 15
Aggregate	3 26	1 51	4 77	2,818.84	5.07	9 38	39 42

c

To produce one ton of lead, by regions and processes.

d

Process.	Region.	Value of fuel.	Value of other supplies.	Total value of all supplies.	Ore used.	Total number of days.	Total wages paid, including staff.	Total capital.
					Pounds.			
Scotch hearth	Upper Mississippi	$1 57	$0 63	$2 20	2,822.67	3.03	$3 88	$31 88
Do	Lower Mississippi	1 97	74	2 71	2,629.71	3.97	8 77	29 45
Do	South and east of Ohio river	2 51	1 35	3 86	4,316.03	4.06	4 91	45 15
	Total all regions	1 93	74	2 67	2,689.12	3.85	8 15	30 09
Air	Upper Mississippi	2 41	66	3 07	3,260.27	3.61	7 16	51 08
Do	Lower Mississippi	1 92	55	2 47	2,905.17	3.18	5 27	21 29
	Total all regions	2 11	59	2 70	3,041.15	3.35	6 00	32 77
Blast	Lower Mississippi	6 86	4 07	10 93	2,897.63	9.50	14 54	64 69
Flintshire	do	8 51	3 37	11 88	3,631.85	7.33	13 32	73 53

This table shows the relative efficiency of work in the states, regions, and processes. It is computed from data furnished by the preceding tables, the basis of calculation being the ton of product. As it is intended to show the cost of production exclusive of the value of the ore, values of the materials, etc., are given in preference to quantities. f One or two points require slight explanation. As in the preceding tables, the values are at the furnace, therefore care must be exercised in considering the contents and studying the varying conditions. Referring to the pounds of ore required to produce 1 ton of lead, the difference in the figures of this column in the same process are not only due to skill in working, but very largely to the degree to which the ore is dressed, some smelters using ore much more free from dirt, clay, and "tiff" than others.

In Missouri the low figures of the ore consumed are due to the Scotch-hearth process, while the high figures for supplies and labor are traceable to the blast and Flintshire furnaces, their ore from its nature requiring dressing from 6 per cent. up to 70 per cent. or more, roasting and fluxing. But they turn out an immense product, capable of being produced from the raw material (rock carrying 6 per cent. galena) in no other manner. Consequently, while more expensive than other processes, there are advantages accruing outbalancing the disadvantages.

a TABLE 56.—*Relation of product to lead ores consumed, by states.*

Region.	Ores reduced.	Lead obtained from same.	Per cent. obtained.
	Pounds.	*Pounds.*	
Illinois	2,457,404	1,685,797	68.6
Iowa	1,987,582	1,394,824	70.2
Wisconsin	7,653,909	5,101,418	66.6
Total	12,098,895	8,182,039	67.6
b			
Kansas	9,176,500	6,365,551	69.3
Missouri	70,530,676	51,059,060	72.4
Total	79,707,176	57,425,151	72.0
South and East of Ohio River region	1,912,000	886,868	46.4
Aggregate	93,718,071	66,494,058	71.0

c *Relation of product to lead ores consumed, by regions and processes.*

Process.	Region.	Ores reduced.	Lead obtained from same.	Per cent. obtained.
		Pounds.	*Pounds.*	
Scotch hearth	Upper Mississippi	7,990,972	5,661,151	70.8
Do.	Lower Mississippi	48,639,062	36,991,766	76.1
Do.	South and East of Ohio river	1,912,000	886,868	46.4
	Total	58,542,034	43,539,785	74.4
Air	Upper Mississippi	4,107,923	2,520,888	61.4
d Do.	Lower Mississippi	5,833,584	4,016,431	68.8
	Total	9,941,507	6,537,319	65.9
Blast	Lower Mississippi	18,072,530	12,473,514	69.0
Flintshire	do	7,162,000	3,943,440	55.1

This table represents the average working results of the treatment of ores. While it is impossible to assert that the product was the actual outcome of the ores appearing in the other column, owing to the difficulty attending the separation of one year's work from another, the results are nevertheless very close, and furnish another means of comparison under the varying conditions of locality and process.

e TABLE 57.—*Machinery employed in the reduction of lead ores, by states.*

Region.	Horse-power of engines.	Engines.	Boilers.	Water-wheels.	Pumps.	Crushers.	Rolls.	Screens.	Jigs.	Other machines.	Blowers.	Total value of all machinery.
		Number.	*Number*	*Number.*	*Number*	*Number.*	*Number.*	*Number.*	*Number*	*Number.*	*Number.*	
Illinois				4							4	$1,500
Iowa	20	2	2	3							4	2,775
Wisconsin				6							6	1,925
Total Upper Mississippi region	20	2	2	13							14	6,200
Kansas	45	1	1		1					3	1	2,300
Missouri	685	50	35	5	32	13	21	27	104	26	20	237,435
Total Lower Mississippi region	730	51	36	5	33	13	21	27	104	29	21	239,735
South and East of Ohio River region	8	1	1	4	3		4		6		2	3,700
Aggregate	758	54	39	22	36	13	25	27	110	29	37	a249,635

a This total includes 5 portable engines.

TABLE 57.—*Machinery employed in the reduction of lead ores, by regions and processes*—Continued.

Process.	Region.	Horse-power of engines.	Engines.	Boilers.	Water-wheels.	Pumps.	Crushers.	Rolls.	Screens.	Jigs.	Other machines.	Blowers.	Total value of all machinery.
			Number.	*Number*	*Number.*	*Number*	*Number.*	*Number.*	*Number.*	*Number*	*Number.*	*Number.*	
Scotch hearth	Upper Mississippi	20	2	2	13							14	$6,200
Do	Lower Mississippi	345	12	13	5	6	5	4	4	22	6	17	39,460
Do	South and East of Ohio river	8	1	1	4	3		4		6		2	3,700
Total		373	15	16	22	9	5	8	4	28	6	33	49,360
Air													
Blast	Lower Mississippi	185	35	14		20	5	9	11	52	18	4	150,275
Flintshire	do	200	4	9		7	3	8	12	30	5		50,000

TABLE 58.—*Comparative view of lead industry for the years* 1850, 1860, 1870, *and* 1880.

Year.	Total number of establishments.	Value of material.	Amount of ore smelted.	Number of hands.	Wages.	Product pig-lead.	Value of all product.	Capital.
1850	156	$1,532,585		753	$181,756		$2,150,068	$603,196
1860	23	724,297		164	45,084		839,222	218,922
1870	62	2,807,074	104,586,000	589	237,628	43,030,000	3,499,183	2,199,600
1880	57	2,465,610	93,718,071	726	274,418	*66,494,058	3,282,390	1,310,594

*See note, page 814.

THE ZINC INDUSTRY.

TABLE 59.—*Zinc-smelting works.*

	TOTAL.		EASTERN WORKS.		ILLINOIS.		KANSAS.		MISSOURI.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Number of counties	9		4		2		2		1	
Number of establishments	13		4		4		2		3	
MATERIALS.										
Fuel used in reducing ores, etc.:										
Anthracite coal ... pounds	20,142,119	$25,312			20,142,119	$25,312				
Bituminous coal ... pounds	276,233,286	193,261	34,413,046	$34,413	159,036,240	101,239	29,282,000	$13,922	53,502,000	$43,687
Coke ... pounds	3,102,000	4,427			400,000	300	2,522,000	4,037	180,000	90
Charcoal ... bushels										
Wood ... cords	442	1,326			442	1,326				
Fuel used for power:										
Coal ... pounds	20,557,773	14,235	2,237,084	2,237	15,286,689	9,508	1,256,000	577	1,778,000	1,913
Wood ... cords										
Other supplies:										
Fluxes										
Finished materials		64,462		11,000		38,694		6,825		7,943
Total value of all supplies		303,023		47,650		176,379		25,361		53,633
Ores reduced:										
Galena ... pounds	680,000	17,000			680,000	17,000				
Blende ... pounds	77,797,392	770,185	13,932,837	69,660	45,900,177	528,620	12,517,463	117,435	5,446,915	54,470
Silicate of zinc ... pounds	43,380,691	379,116	8,305,300	61,165	11,916,121	86,602			23,159,270	231,349
Carbonate of zinc ... pounds	6,188,060	35,333			548,060	4,313			5,640,000	31,020
Total of all ores of each metal ... pounds	128,046,143	1,201,634	22,238,137	130,825	59,044,358	636,535	12,517,463	117,435	34,246,185	316,839
Additional ores of zinc whose product was oxide of zinc ... pounds	100,678,343	503,392	100,678,343	503,392						
LABOR.										
Skilled laborers ... No.	550		80		216		82		172	
Days employed ... No.	179,135		29,054		78,385		22,226		49,470	
Net wages		333,538		47,988		129,468		44,173		111,909
Ordinary laborers ... No.	395		89		238		36		32	
Days employed ... No.	128,978		30,048		81,062		10,245		7,623	
Net wages		177,449		40,144		108,303		15,719		13,283
Total wages		510,987		88,132		237,771		59,892		125,192
STAFF.										
Number	27		4		18		5			
Salaries		29,683		6,000		20,368		3,315		

a TABLE 59.—*Zinc-smelting works*—Continued.

	TOTAL.		EASTERN WORKS.		ILLINOIS.		KANSAS.		MISSOURI.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PRODUCTION.										
Pig-lead ..... pounds..	476,780	$19,071	.....	.....	476,780	$19,071	.....	.....	.....	.....
Spelter ..... pounds..	46,477,999	2,862,712	8,426,831	$725,679	21,807,038	1,243,001	4,902,953	$279,468	11,341,177	$614,564
Zinc oxide ..... pounds..	20,213,631	763,738	20,213,631	763,738	.....	.....	.....	.....	.....	.....
Total value of product	.....	3,645,521	.....	725,679	.....	1,262,072	.....	279,468	.....	614,564
CAPITAL.										
Capital, fixed	.....	811,200	.....	125,000	.....	395,200	.....	96,000	.....	195,000
Capital, floating	.....	380,120	.....	67,120	.....	198,000	.....	60,000	.....	55,000

Table 59 represents the statistics for the different regions in which the zinc industry is pursued.

The number of establishments embraces only those engaged in the production of spelter, and in the east it should be observed that while the figures for the product and the ores consumed are deemed reliable, authentic data for the supplies, etc., were so sparse, owing to an inevitable omission of personal visits, that their figures must not be accepted with the same degree of confidence as those of the remaining localities.

c Regarding the derivation of coal, excluding the anthracite screenings which are usually purchased from coal-dealers in the large cities, we find from the schedules that supplies were obtained as follows:

Region.	Supply.	Per cent.
	Pounds.	
Lower Illinois (the Big Muddy field)	55,280,000	18.6
Upper Illinois	174,322,929	58.7
Kansas	30,538,000	10.3
Eastern fields	36,650,130	12.4
Total	296,791,059	100.0

d at the prices, respectively, of $1 63, $1 27, $0 95, and $2 per ton at the works. The Missouri works used Illinois coal mined from 12 to 40 miles distant, the eastern works coal mined at various distances, the remaining works coal mined in close proximity. The processes pursued in Illinois in smelting the majority of the ores, had, on account of the regenerative furnaces used, a marked influence upon the amount of coal consumed.

The coke used in Illinois and Missouri came from Saint Louis, being an inferior quality of gas-coke. That used in Kansas was made in the vicinity of the works, and was of a quality greatly superior to the former.

The derivation of the ores of zinc is noted further on. Of the total ores of zinc of which the product was spelter, namely 127,366,143 pounds, those smelted in eastern works form 17.5 per cent., those in Illinois 45.8 per cent., those in Kansas 9.8 per cent., and those in Missouri 26.9 per cent.

e *Values of zinc ores.*—The price given is nominally based upon the market price of spelter in New York; but in reality, owing to the immense size of a few establishments, it is entirely controlled by them. This is easily done on account of an additional product turned out, namely-rolled or sheet zinc.

Zinc ores consumed.—The disagreement between the ore returns of the mining and the smelting industries appears at first sight enormous, but it can be entirely accounted for. As the simplest and most expeditious mode of explaining it, we present it in a somewhat summarized form, thus: From the smelting schedules, deducting 680,000 pounds for lead ore given in the total ores of zinc-works, we have—

	Pounds.
Total zinc ores smelted (of which the product was spelter)	127,366,143
Total zinc ores smelted (of which the product was oxide of zinc)	100,678,343
Total zinc ores smelted	228,044,486
f Zinc ores purchased and at works (but not smelted)	2,435,965
Total ores of zinc shown on smelting schedules	230,480,451
Eastern ores per mining schedule	148,318,000
Western ores per mining schedule	98,418,000
Total shown on mining schedules, as mined	246,736,000
Total shown on smelting schedules, as mined	230,480,451
Difference in favor of mining schedules, to be accounted for	16,255,549

Or 7.9 per cent. expressed in a percentage of smelter's returns. For the full understanding of this discrepancy the composition of the figures given above must be considered. For this purpose we have used the terms

"Western" and "Eastern", the Western division comprising the southwest region of Missouri and Kansas, and a the northwest one of Illinois and Wisconsin, the Eastern division comprising all the works east of the Appalachian mountains. It may be observed in this connection that the ores mined in the above divisions are smelted by the works in their respective divisions and not transferred from one to the other, except in the case of Tennessee, a portion of whose ores goes to the Western and a portion to the Eastern division. With this understanding, and bearing in mind that we are dealing in a case of smelter's returns, with the total ores that have reached their hands, whether smelted or not, we first notice the total ores of the west, which are again immediately afterward presented in the two sections of the southwest and northwest for more conclusively tracing any difference of returns appearing in this division.

WESTERN DIVISION.

b

	Pounds.
Total ores appearing on smelter's schedules, as mined and purchased, including ores reduced to oxide of zinc in the west	110,291,971
Total ores mined, as per mining schedules	98,418,000
Excess of ore per smelting returns over ore per mining returns	11,873,971

Or 10 per cent. of the ore appearing on the smelter's schedules, traceable thus:

Tennessee ores mined and smelted, balance each other.

	Pounds.
Ores mined in southwest district, as per mining schedules	83,194,000
Ores mined and purchased in same district, as per smelting schedules	84,172,951
Excess of ore per southwest smelting schedules over ore per mining schedules	978,951

c

Equivalent to 1.1 per cent. of smelter's returns, much within a legitimate variation.

	Pounds.
Ores mined in northwest district per mining schedules	15,234,000
Ores mined and purchased in same district per smelting schedules	25,637,020
Excess of northwest ore per smelting returns over ore per mining returns	10,403,020

Equivalent to 40.6 per cent. of smelter's returns. A large difference, but to be explained in the same manner as was the large difference between the lead returns of the same region.

EASTERN DIVISION. d

Previous to presenting the figures relating to the work in the Eastern region, it should be remarked that the figures representing the ores consumed in the manufacture of spelter are deemed correct. In the case of ores yielding oxide of zinc, the figures are drawn from several sources, such as, 1st, the returns of the ores by the manufacturers; 2d, the returns on the mining schedules that can be traced to their actual destination.

	Pounds.
Total ores appearing on mining schedules of the east	148,318,000
Totals ores smelted appearing on smelting returns	120,188,480
Excess of ore on mining returns over ore on smelting returns	28,129,520

Or 23 per cent. of the smelted ores. Upon investigation of the mining schedules this entire amount from eastern e mines was found not to have been smelted, nor to have found its way into the hands of the smelter. It is due to various legitimate causes, the chief being the want of preparation by mining companies to reduce their own ores, and a consequent accumulation thereof until late in the year, their mines being worked during the entire year.

By the following scheme the discrepancy will be seen to be thus distributed:

	Pounds.
For the entire country, ore by mine returns exceeds ore by smelter's returns by	16,255,549
For the Western division, ore by mine returns less than ore by smelter's returns by	11,873,971
For the Eastern division, ore by mine returns exceeds ore by smelter's returns by	28,129,520

The excess of zinc ore on mine returns of the east not only balances the deficiency of zinc ores on mine returns of the west, as compared with smelter's returns, but leaves an excess of zinc ore on mine returns for the entire f country of 16,255,549 pounds.

TABLE 60.—*Percentages of metal obtained from the ores, by regions.*

Region.	Ores reduced.	Blende.	Silicate.	Carbonate.	Product obtained.	Metal obtained.
	Tons.	*Per cent.*	*Per cent.*	*Per cent.*	*Tons.*	*Per cent.*
Eastern works	22,238,137	62.7	37.3	.....	8,426,831	37.9
Illinois	58,364,358	78.7	20.4	0.9	21,807,038	37.4
Kansas	12,517,463	100.0	.....	.....	4,902,953	39.2
Missouri	34,246,185	16.0	67.6	16.4	11,341,177	33.1
Total	127,366,143	61.1	34.1	4.8	46,477,999	36.5

a The following represents the percentages of the total product obtained in each locality.

Region.	Per cent.
Eastern works	18.1½
Illinois, La Salle and Peru regions, and one small concern in South Illinois.	46.9
Kansas (eastern part)	10.5½
Missouri (Saint Louis)	24.4
Total	100.0

b A small amount of lead from mineral coming in with their zinc ores was produced by one establishment in Illinois. This was obtained in part direct, and in part by dressing machinery, and is accounted for both in the note under the lead industry (p. 814), and in the table of grand totals, No. 53.

TABLE 61.—*Average cost of materials, labor, etc., per ton of metal produced.*

c

Region.	Value of fuel.	Value of other supplies.	Total value of all supplies.	Pounds of ore used.	Total number of days.	Total wages, including staff.	Total capital.	Tons of product.
Eastern works	$8 69	$2 61	$11 30	5,277.94	14.02	$22 34	$45 59	1
Illinois	12 62	3 55	16 17	5,415.17	13.70	23 67	54 40	1
Kansas	7 56	2 78	10 34	5,106.10	13.24	25 78	63 63	1
Missouri	8 05	1 40	9 45	6,039.26	10.07	22 08	44 09	1
Total	10 26	2 77	13 03	5,509.97	13.26	23 26	51 26	1

The percentage of capital employed in the various states is as follows:

d

Region.	Fixed.	Floating.	Total.
Eastern works	15.4¼	17.6¾	16.1½
Illinois	48.7¼	52.0¾	49.8
Kansas	11.8¼	15.7¾	13.1
Missouri	24.0¼	14.4¾	20.9½
Total	100.0	100.0	100.0

The high percentage of the capital employed in Illinois might mainly be assigned to two large works. The fixed capital conveys an excellent idea of the extent of the plant.

TABLE 62.—*Representation of the furnace plant of the zinc smelters of the western states.*

Region.	Number of Belgian furnaces.	Number of retorts in each.	Number of Siemens furnaces.	Number of retorts in each.	Number of M. and H. patent furnaces.	Number of retorts in each.	Total number of retorts.	Total daily capacity in pounds of roasted ore.	Number of reverberatory roasting-furnaces.	Number of roasting-kilns.
Illinois	25	From 50 to 127	3	1 of 192, 2 of 284	4	2 of 360, 2 of 288	4,188	205,260	21	5
Kansas	8	4 of 98, 4 of 106	0		0		816	39,600	18	0
Missouri	26	90 to 180	0		0		2,628	139,500	5	5
Total	59		3		4		7,632	384,360	44	10

NOTE.—Of the roasting-furnaces 2 are gas, 2 hot-air, 16 ordinary, of from 2 to 4 hearths, 1 automatic.

This table is representative of the furnace plant of the zinc smelters of the western states, that of the eastern not having been obtained, owing to the nonvisiting of their works and the impossibility of getting satisfactory results from letters alone. In giving the number of furnaces, single furnaces and not blocks are understood. But, of the extent of plant, the best idea can be gathered from the number of retorts, the average daily charge of f roasted ore per retort being 50 pounds. The roasting-furnaces are usually of two or three hearths, and are calculated to keep even in their work with the demands of the Belgian furnaces. In addition to this plant, there are drying-kilns for retorts, condensers, and tiles, all of which are made at the works and included under finished materials in Table No. 59.

TABLE 63.—*Mechanical plant employed in the reduction of zinc ores.*

Region.	Horse-power of engines.	Engines.	Boilers.	Water-wheels.	Pumps.	Crushers.	Rolls.	Screens.	Jigs.	Other machines.	Blowers.	Total value of machinery.
Illinois	320	9	13	1	9	3	14	12	7	23	2	$40,774
Kansas	100	3	2		3		8	5		5		6,825
Missouri	153	5	4		3		8	3	2	8		10,770
Total	573	17	19	1	15	3	30	20	9	36	2	58,469

The labor of the zinc establishments is much more capable of a proper division into "skilled" and "ordinary" a
labor than that of the lead-works. The line of demarkation is quite sharp, being usually drawn between the "long-shift men" and the "half-shifts" among the furnacemen, and including, as in other cases, mechanics among the "skilled" workmen, and yard hands, etc., among the ordinary.

The following are the day's wages obtained in the different localities:

Localities.	Skilled labor.	Ordinary labor.
Eastern works	$1 65	$1 33
Illinois	1 65	1 33
Kansas	1 98	1 53
Missouri	2 26	1 74
Total	1 86	1 37

b

The skilled labor is by no means all of one class, but the daily wages paid range from $1 75 to $2 75. This labor is also mostly foreign, consisting largely of Belgians coming to this country both at the instigation of the zinc smelters and of their own accord.

THE COPPER INDUSTRY.

TABLE 64.—*Copper-smelting works.* c

	EASTERN WORKS.		WESTERN WORKS.		TOTAL.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Number of establishments	6		2		8	
MATERIALS.						
Fuel used in reducing ores:						
Coal ... pounds	15, 488, 000	$28, 626	32, 141, 867	$59, 077	47, 629, 867	$87, 703
Coke ... pounds	524, 000	1, 585	486, 000	1, 498	1, 010, 000	3, 083
Charcoal ... bushels	1, 315, 000	131, 500	46, 022	6, 260	1, 361, 022	137, 760
Wood ... cords	13, 100	29, 135	10	40	13, 110	29, 175
Wood ... poles	5, 500	1, 833	25, 500	8, 500	31, 000	10, 333
Fuel used for power:						
Coal ... pounds	4, 900, 000	7, 268	4, 520, 400	8, 335	9, 420, 400	15, 603
Wood ... cords	1, 460	3, 576			1, 460	3, 576
Other supplies:						
Fluxes ... value		2, 000		5, 520		7, 520
Finished materials ... value		10, 000		23, 553		33, 553
Total value of all supplies		215, 523		112, 783		328, 306
Ores reduced:						
Native copper ... pounds			58, 361, 070	5, 842, 909	58, 361, 070	5, 842, 909
Other ores of copper ... pounds	66, 699, 023	652, 801			66, 699, 023	652, 801
Nickeliferous pyrrhotite ... pounds	14, 850, 000	150, 000			14, 850, 000	150, 000
Total of all ores of each metal ... pounds	81, 549, 023	802, 801	58, 361, 070	5, 842, 909	139, 910, 093	6, 645, 710
Metals refined:						
Copper matte refined ... pounds	12, 528, 779				12, 528, 779	
LABOR.						
Skilled laborers ... No.	176		101		277	
Number of days made by same	39, 384		30, 656		70, 040	
Net wages of same		85, 888		88, 173		174, 061
Ordinary laborers ... No.	228		135		363	
Number of days made by same	53, 429		35, 638		89, 067	
Net wages of same		71, 124		65, 427		136, 551
Total wages		157, 012		153, 600		310, 612
Staff:						
Number of staff	15		15		30	
Total salaries of same		15, 000		26, 600		41, 600
PRODUCTION.						
Nickel and cobalt ... pounds	310, 117	310, 117			310, 117	310, 117
Ingot copper ... pounds	9, 041, 884	1, 591, 571	45, 130, 133	7, 870, 682	54, 172, 017	9, 462, 253
Blue vitriol (sulphate of copper) ... m ... pounds	533, 786	37, 365			533, 786	37, 365
Total value of product		1, 939, 053		7, 870, 682		9, 809, 735
CAPITAL.						
Capital, fixed		575, 500		468, 000		1, 043, 500
Capital, floating		309, 000		210, 000		519, 000

a Table No. 64 needs no lengthy comment.

The supply of coal for the copper industry of the lake region is drawn from Ohio, in connection with Pennsylvania, but it is impossible to give the relative quantities coming from each. That used in the eastern works is from eastern fields.

Pennsylvania supplies the entire demand for coke.

The ores of copper smelted in the eastern works are brought up to the large weight indicated, from the fact that the quantities reported are from ores as they entered the furnace, some of them containing but 4 per cent. of copper. This must be borne in mind when considering their amount in connection with that from the Lake Superior region, which was altogether native copper.

b The figures marked nickeliferous pyrrhotite are those for the ores of nickel yielding copper as an accessory product. They were placed with the copper, as they contained a slight amount of this metal, but from their difference in character, it was not thought best to combine the two under the same name.

The great difference between the returns of copper ore consumed by the smelters and that returned under mining, is due to the fact that the figures of mining schedules represent rock, whereas those of the smelters represent the mineral and ore as ready for the smelters' treatment.

In the product, the accessory portion of blue vitriol (sulphate of copper) is from the nickel ores.

The entire product of ingot copper during the census year was 54,172,017 pounds. In the preliminary bulletin issued upon copper, the product of the extreme western states and territories, Colorado, Arizona, Idaho, California,
c Alaska, Montana, Nevada, and New Mexico, is given as 5,410,546 pounds, based entirely upon the assay value of the ore in copper. This would make the total mining returns 56,320,266 pounds, being 2,147,249 pounds in excess of the figures as returned by smelters, a difference of about 4 per cent. expressed in the percentage of the smelters' product. This discrepancy was to be expected. The returns from the extreme west are based on the assay value of the ore at the mines. The mines and the smelting-works being in some cases remote from each other, the statements of ingot-copper product for the mines and of ingot-copper product at the smelters would hardly agree at the close of the census year, even if, in a final settlement of accounts, their statements were harmonious. Another element of discrepancy between the product as returned from mines and that returned from smelting works, lies in the export of ore mined and the use of imported ore by smelters (see table).

d TABLE 65.—*Leading statistics of materials, etc., based upon a product of* 1 *ton of copper.*

Region.	Value of fuel.	Value of other supplies.	Total value of all supplies.	Pounds of ore used.	Total number of days.	Total wages, including staff.	Total capital.	Tons of product.
Eastern works	$45 02	$2 65	$47 67	14,753.35	20.54	$38 04	$195 64	1
Western works	3 71	1 28	4 99	2,586.34	2.94	7 94	30 04	1
Total	10 60	1 52	12 12	4,617.15	5.88	13 00	57 66	1

TABLE 66.—*Smelting and refining works east of* 100*th meridian.*

e

	UNITED STATES. Quantity.	UNITED STATES. Value.
Number of establishments	5	
MATERIALS.		
Fuel used in reducing ores, etc.:		
Coal ... pounds	48,323,041	$76,716
Coke ... pounds	21,437,071	71,619
Charcoal ... bushels	1,700	102
Wood ... cords	40	200
Fuel used for power:		
Coal ... pounds	18,452,800	33,983
Other supplies:		
Fluxes		12,660
Spelter ... pounds	8,089,552	383,888
Finished materials		34,324
Total value of all supplies		613,492
Ores reduced:		
Galena ... pounds	1,201,519	12,180
Gold and silver ores ... pounds	18,185,846	a 1,318,545
Contents in gold, 6,020 ounces; silver, 1,200,596 ounces; lead, 2,611,988 pounds.		
Total of all ores of each metal ... pounds	19,387,365	a 1,330,725
Metals refined:		
Base bullion ... pounds	99,663,460	
Copper matte, refined ... pounds	79,839	

	UNITED STATES. Quantity.	UNITED STATES. Value.
LABOR.		
Skilled laborers ... No.	179	
Days employed	60,652	
Net wages		$138,344
Ordinary laborers ... No.	516	
Days employed	160,087	
Net wages		273,679
Total wages		412,023
Staff:		
Number	37	
Total salaries		70,734
PRODUCTION.		
Pig-lead ... pounds	95,967,267	4,737,634
Sulphate of copper or blue vitriol ... pounds	100,000	6,000
Gold ... ounces	48,891	1,010,570
Silver ... ounces	13,226,444	14,882,060
Total value of product		20,636,264
CAPITAL.		
Capital, fixed		606,750
Capital, floating		896,250

a Estimated in part.

Table 66 would be best discussed from the metallurgical side. Statistically, it cannot be discussed except as a whole, as there enter into its composition the figures derived from many different steps in the process of extraction of the product, each of which is varying from one day to another, in accordance with the raw or partially raw material to be refined. It may, however, be noted, first, that the sources of the coal consumed are as follows:

Region.	Consumption.	Per cent.
	Pounds.	
Illinois	11,975,000	17.93
Pennsylvania	25,517,030	38.21
Iowa	29,283,811	43.86
Total	66,775,841	100.00

b

The source of coke is Pennsylvania, with the exception of 4,735,000 pounds, which came from the Carbondale field of Illinois. The spelter is the amount purchased and employed during the census year, as nearly as can be obtained. It is, of course, used more than once, which fact hinders us from getting at the exact amount consumed, though the purchasers from year to year are supposed to represent it pretty closely.

The ores are from the west, with the exception of the galena, and 84,159 pounds of argentiferous ore from Missouri and Arkansas, containing 2,936.37 ounces of silver.

As to the base bullion refined and product given in this table, there should be added to these figures those of c the western works, the resulting figures then representing the entire consumption of base bullion by, and the product of, the precious-metal smelting- and refining-works. These figures are from data furnished in the *Report of the Precious Metal Statistics* by Mr. King, and are for: Base bullion refined, 2,722,445 pounds (estimated), yielding 2,586,370 pounds refined pig-lead, having a value of $122,853; about 423 ounces of gold, valued at $8,743 41; and a probable 136,728 ounces of silver, of a market value of $153,819; thus increasing the corresponding figures of this table for the base bullion treated to 102,385,905 pounds; the refined lead to 98,553,637 pounds, of a total value of $4,860,487; the gold to 49,314 ounces, of a value of $1,019,313; the silver to 13,363,172 ounces, at the market value of $15,035,879.

TABLE 67.—*Grand total of smelting-works.*

	UNITED STATES, EAST OF THE 100TH MERIDIAN.	
	Quantity.	Value.
Number of establishments	83	
MATERIALS.		
Fuel used in reducing ores, etc.:		
Coal ... pounds	394,804,713	$390,438
Coke ... pounds	32,088,731	108,698
Charcoal ... bushels	1,511,413	149,760
Wood ... cords	27,153	58,372
Wood ... poles	31,000	10,333
Fuel used for power:		
Coal ... pounds	57,555,515	73,434
Wood ... cords	12,649	25,875
Other supplies:		
Fluxes ... value		40,173
Spelter ... pounds	8,089,552	383,888
Finished materials ... value		162,484
Total value of all supplies		1,403,455
Ores reduced:		
Galena ... pounds	95,517,390	2,342,205
Dry bone ... pounds	82,200	1,009
Blende ... pounds	77,797,392	770,185
Silicate of zinc ... pounds	43,380,691	379,116
Carbonate of zinc ... pounds	6,188,060	35,333
Additional ores of zinc, of which the product is oxide of zinc ... pounds	100,678,343	503,392
Native copper ... pounds	58,361,070	5,842,909
Nickeliferous pyrrhotite ... pounds	14,850,000	150,000
Other ores of copper ... pounds	66,699,023	652,801
Gold and silver ores ... pounds	18,185,846	a 1,318,545
Contents in—		
Gold ... 6,020 ounces.		
Silver ... 1,200,596 ounces.		
Lead ... 2,611,988 pounds.		
Total all ores of each metal ... pounds	481,740,015	11,995,495

	UNITED STATES, EAST OF THE 100TH MERIDIAN.	
	Quantity.	Value.
MATERIALS—continued.		
Metals refined:		
Base bullion refined ... pounds	99,663,460	
Copper matte refined ... pounds	12,608,618	
LABOR.		
Skilled laborers ... number	1,395	
Number of days employed	394,985	
Net wages		$810,804
Ordinary laborers	1,611	
Number of days employed	461,444	
Net wages		697,236
Total wages		1,508,040
Staff:		
Number of staff	121	
Total salaries		179,485
PRODUCTION.		
Pig-lead ... pounds	162,938,105	7,935,140
Nickel and cobalt matte ... pounds	38,293	5,514
Nickel and cobalt ... pounds	310,117	310,117
White lead ... pounds	2,156,100	86,244
Blue lead ... pounds	348,489	12,197
Spelter ... pounds	46,477,999	2,862,712
Zinc oxide ... pounds	20,213,631	763,738
Ingot copper ... pounds	54,172,017	9,462,253
Sulphate of copper or blue vitriol ... do	633,786	43,365
Gold ... ounces	48,891	1,010,570
Silver ... ounces	13,226,444	14,882,060
Total value of product		37,373,910
CAPITAL.		
Capital, fixed		3,336,799
Capital, floating		2,230,615

a Estimated.

a Table 67 is merely a summation of the statistics of the various metals already presented in tabular form. To embrace the entire area of the United States the same additions should be made to the amount of base bullion refined and its products as were made in Table 66, by which the figures of those items in this table would be brought up to.

	Weight.	Value.
Base bullion treated ..... pounds..	102, 385, 905	.....
Pig-lead produced ..... pounds..	165, 524, 475	$8, 057, 993
Gold produced ..... ounces..	49, 314	1, 019, 313
Silver produced ..... ounces..	13, 363, 172	15, 085, 879
Total value of product	.....	37, 659, 325

b

In connection with Table No. 67 and the following ones (Nos. 68 to 74), it is of interest to note the consumption of the various metals as therein illustrated, a summary of which is presented in the following figures, those products of Table 67 to which the figures do not refer remaining unchanged by imports or exports, and it is to be presumed having been consumed or used in the various manufactures of the United States.

	Quantity.	Value.
	Pounds.	
Pig-lead consumed in manufactures	173, 126, 852	$8, 332, 072
Zinc consumed in manufactures	58, 678, 075	3, 394, 272
Copper consumed in manufactures	54, 994, 388	9, 573, 808
Value of all metals consumed	.....	38, 576, 519

c

IMPORTS AND EXPORTS.

Tables 68 to 74, inclusive, represent the chief ore and metal importations and exportations during the year ending May 31, 1880.

TABLE 68.—*Imports and exports of ores of copper.*

d

IMPORTS.

From—	Customs district where imported.	Quantity.	Value.
		Pounds.	
England	Boston	26, 000	$2, 693
Quebec, etc	Vermont	4, 048, 300	182, 387
Total	.....	4, 074, 300	185, 080

EXPORTS OF DOMESTIC ORES.

e

To—	Quantity.	Value.	Customs district whence imported.	Quantity.	Value.
	Pounds.			*Pounds.*	
Germany	681, 100	$16, 300	New York and San Francisco.	1, 262, 300	$24, 950
England	1, 481, 200	39, 463	....do	900, 000	30, 813
Total	2, 162, 300	55, 763	.....	2, 162, 300	55, 763

EXPORTS OF FOREIGN ORES.

To—	Custom districts whence exported.	Quantity.	Value.
		Pounds.	
England	Boston	226, 800	$9, 810

f

Summarizing, we have—

	Quantity.	Value.
	Pounds.	
Imports	4, 074, 300	$185, 080
Exports of foreign ore	226, 800	9, 810
Imports remaining	3, 847, 500	175, 270
Exports of domestic ore	2, 162, 300	55, 763
Excess of imports over exports	1, 685, 200	119, 507

Thus we see that the ores of copper smelted in this country, as by the table, 139,910,093 pounds, must be a diminished by the importation of foreign ores, amounting to 3,847,500 pounds, bringing the former amount down to 136,062,593 pounds, representative of the domestic ores reduced by the smelters east of the 100th meridian. These foreign ores may be classified with those "other than native copper", and were reduced by the smelters of the Atlantic states. Our own eastern smelters complain that the demand for ores far exceeds the supply afforded by domestic mines. The exports contain ores considered too difficult for treatment, or requiring a method distinct from those in use by our own smelters.

It is observed that our imports still exceed the exports by 1,685,200 pounds. Our imports were formerly far in excess of this amount, but upon the imposition of the duty the eastern operators were obliged to allow this branch of their works to decline. b

TABLE 69.—*Imports and exports of ores of silver and gold.*

IMPORTS.

Customs district where imported.	Quantity.	Value.
	Pounds.	
New Orleans	224	$10
New York	*a* 83,640	12,546
San Francisco	126,903	23,066
Lake ports	1,632,476	240,455
Other ports	*a* 3,813	572
Total	1,847,056	276,649

c

a Estimated.

EXPORTS OF DOMESTIC ORES.

To—	Quantity.	Value.	Customs district whence exported.	Quantity.	Value.
	Pounds.			*Pounds.*	
Unknown	36,500	$6,000	Boston	36,500	$6,000
Belgium	900	900	do	942,200	167,500
Germany	81,700	17,750	New York	21,000	9,000
England	949,200	168,700	San Francisco	68,600	10,850
Total	1,068,300	193,350		1,068,300	193,350

d

EXPORTS OF FOREIGN ORES.

Customs district whence exported.	Quantity.	Value.
	Pounds.	
New York	22,700	$2,250

e

Summarizing, we have—

Imports and exports.	Quantity.	Value.
	Pounds.	
Imports	1,847,056	$276,649
Exports of foreign ores	22,700	2,250
Imports remaining	1,824,356	274,399
Exports of domestic ore	1,068,300	193,350
Excess of imports over exports	756,056	81,049

f

What became of the 1,824,356 pounds of imported ore is a question, as it has been impossible to trace it to any establishment in this country.

TABLE 70.—*Imports and exports of zinc.*

Imports or exports.	Condition.	Quantities.	Values.
		Pounds.	
Imports of zinc, spelter, or tutenag, and manufacturers of	In blocks or pigs	8,514,826	$393,334
	In sheets	5,101,902	260,056
Exports of domestic zinc-plates	Sheets, pigs, or bars	1,368,302	119,264
Exports of foreign zinc, spelter, or tutenag, and manufactures of	In sheets	48,350	2,566

a

TABLE 71.—*Imports and exports of lead.*

	Quantities.	Values.
	Pounds.	
Imports of lead, pigs, bars, and old	8,742,118	$325,076
Exports of domestic lead, and manufactures of	a1,108,866	49,899
Exports of foreign lead, pigs, bars, and old	30,875	1,098

a Estimated.

b

TABLE 72.—*Imports and exports of copper.*

	Quantities.	Values.
	Pounds.	
Imports of copper, pigs, bars, ingots, old, and other, manufactured	5,262,086	$821,329
Exports of domestic copper, pigs, bars, sheets, and old	4,206,258	667,242
Exports of foreign copper, pigs, bars, ingots, old, and other, manufactured	233,457	42,532

c

TABLE 73.—*Imports and exports of tin.*

	Quantities.	Values.
	Cwts.	
Imports of tin in bars, blocks, or pigs	284,960	$6,223,176
Exports of foreign tin in bars, blocks, or pigs	4,116	82,594

TABLE 74.—*Imports and exports of bullion.*

d

	Bars.	GOLD.		SILVER.	
		Bullion.	Dust.	Bars.	Bullion.
Imports	$16,274,188	$3,179,567	$883,690	$985,083	$996,342
Exports, domestic		87,066			6,912,864
Exports, foreign	104,204	195,845			128,664

MINOR MINERALS

OF THE

UNITED STATES.

MICA MINES OF NEW ENGLAND.

By N. S. Shaler.

Mica is obtained from several highly decomposed species of minerals belonging to the group of unsilicates. They constitute a part of all granites, and occur in many other forms of rocks. The well-recognized varieties c are muscovite, which contains potash and some soda; phlogopite when magnesia takes the place of potash and soda; biotite, which adds a considerable amount of iron to the manganese found in phlogopite. Besides these three principal variations rarer varieties occur, known as ripidolite, astrophyllite, lepidomelane, etc., each characterized by certain variations in the proportion or character of their subordinate constituents. Of these various forms only two have, or are likely to have, any commercial importance. These are muscovite, or potash-mica and phlogopite, or magnesia mica. The others are either so rarely found or so little fitted by their physical characters for use that they may be neglected in any economic consideration of the group. All our granite rocks contain micas, and it is to them that we must always look for the supply of this substance; when it occurs with other rocks it is, I believe, universally of unworkable quality.

The first use made of mica in Europe was in the construction of lanterns, a service for which its peculiar d qualities very well fit it. Under the name of Muscovy glass considerable quantities of it have been used in Europe for several centuries.

In Europe and Asia it seems to have been unknown to the ancients; in America, on the other hand, it appears to have been highly prized by the aborigines throughout the Atlantic coast and the Mississippi valley. The reason of the esteem in which they held it is not clear, nor do I know of any descriptions of its use as ornaments among our living Indians. Yet it is a fact that by far the greater part of the Indian graves throughout the region east of the Mississippi contain one or more pieces of mica, which were evidently buried with the corpse. In some cases the amount of mica is so considerable that the upper part of the body seems to have been pretty well covered over with it. In other cases the bit or bits are so small that they would escape the eye of any one not on the lookout for it. This supply of mica seems to have been altogether obtained by the Indians from the mines of the western e Carolinas. There are considerable openings upon these mines which were made by the aborigines, and the opinion of modern writers is to the effect that a good deal of discrimination was shown in selecting the best localities for working. Although I have carefully inquired concerning the existence of pits of ancient date about the mica localities in New England, I have been unable to ascertain that any such evidences of old workings have been found in that part of the country. The presence of mica among the graves is therefore evidence of a certain amount of intercourse among these widely-separated tribes before the settlement of America. So far as I have been able to learn this use of mica as an ornament, and especially its inhumation with the dead, is peculiar to the Indians of this country. It deserves more inquiry than I have been able to give to it.

The mica that is mined in this country and Canada is altogether obtained from the rocks of a granitic character, which probably all belong to deposits of Laurentian, Montalban, or Huronian age. I am informed by Dr. T. f Sterry Hunt that the Canada mica is of the phlogopite or magnesian variety, while that mined in the United States is entirely muscovite. The worked mines of the United States are all in the western part of the Carolinas or in New Hampshire, with the exception of a single locality in Maine, so close to the New Hampshire line that it may fairly be regarded as a part of the last-named district. In these regions mica is very plentiful in the granitic rocks, but is generally distributed in the shape of small crystals, not exceeding at most half an inch on the side. At various points, however, local causes have served to gather the mica into very much larger crystals, which sometimes are as much as a foot in their greatest diameter. The cause of the local deposits of large crystals is not easy to determine. In the Carolinas they appear to occur in distinct veins or dikes of an injected nature. In the New Hampshire district they do not have this distinct character. They rather appear to be obscure beds closely following the general run of the apparent bedding that characterizes the granites in this part of the country. In these beds or dikes the principal part of the mass is feldspar, but there are generally some other conspicuous

a minerals, of which beryl is the most prominent. Scattered through this mass, and usually comprising not more than a few per cent. of its volume, we have the crystals of mica. Sometimes they are aggregated into vein-like belts in the mass of feldspar, at other times they are scattered without much order among the other materials.

In the Carolinas the mica is very apt to have a twisted structure, the bedding planes having been forced out of their natural positions by the pressure incident to the crystallizing process. This distortion is relatively rare in the New England deposits. It may be that this is owing to the very wide nature of the masses in which the crystallizing process simultaneously took place in the northern localities.

The Carolina micas are also much more extensively impregnated with foreign substances in dendritic and other forms, which, crystallizing between the plates, destroy their commercial value. The substance of the sheets is also b much more penetrated by coloring matter than those from New England localities, so that in preparing the mica for the market the proportion rejected is necessarily far greater in the southern mines.

This deeper penetration of altering action in the Carolina localities is a part of the general fact that these more southern regions have not received much glacial wear in recent geological times, and so the rocks near the surface which have long been subjected to the action of weathering agencies remain in place, while in northern regions they have been ground off by the ice of recent glacial periods.

The method of working the deposits depends very much upon the distribution of the mica through the territory it is proposed to explore. The several mines in New Hampshire afford us good instances of the processes of mining the substance as it is usually carried on in New England. In most cases the mica is so distributed that it is most c convenient to approach it by open cuts, when the whole of the material containing the mica is removed as it is in a quarry. A good instance of this may be seen at the Hartford mine, in Groton, New Hampshire. At the Ruggles mine, in Grafton, we have an instance of the other method of occurrence; there the mica lies in one or more vein-like aggregations, the feldspar on either side being scantily furnished with crystals of useful size. In this case the method of working is different; the mine is explored by drifting on the mica, leaving it only in case it is necessary to search for the deposit after the productive ground is exhausted. In the Carolinas the mica occuring in distinct dikes of variable widths, but never of the broad character proper to the deposits in New England, it is necessary to mine the substance by means of regular mining operations. The large size of the aggregations of crystals and the relatively small amount of gangue in the richer parts of the veins compensates for the greater cost as well as for the greater amount of impurities and imperfections found in the crystals.

d As soon as an aggregate of crystals is found the vein-matter is removed in as large masses as possible; these are then carefully split to release the mica, which is then taken to the shops, where the preparation for the market is begun. It should be understood that mica is a crystal with planes of cleavage in one direction, along which it is possible to divide the substance to almost any extent. The first stage of its preparation is to split it into thicknesses that will permit it to be formed into the desired shapes by means of shears such as are commonly used in cutting tin plates. The splitting process is accomplished by means of a wide, thin, wedge-like tool; the blocking into the commercial sizes, by the shears. All the mica is prepared to special order, and practically all of it is used for the single purpose of stove-plates; so this stage of the manufacture brings it into the general shape it is to have when put to use. After the split pieces of the mica crystals leave the hands of the men who cleave and shear them into shape, they are turned over to other persons, generally young women, who split the strips to the desired e thickness and remove all the splintery parts of the sheets, wrap them in pound packages, when they are quite ready for market. No well-accepted classification of the mica has yet been adopted. The price is mainly determined by its size; the smaller sizes, containing about 13 to 15 square inches, are worth at present about 40 to 50 cents per pound; the price rises with the increase of square surface in the pieces until those with 60 to 80 inches of surface, which are rarely used, are worth from $5 to $8 a pound. The mica of different localities differs a good deal in its color and hardness, and somewhat in its endurance to heat. Some of it is greenish, some reddish, and the most preferred of a colorless tint. There seems reason to believe that the colorless mica is the most enduring.

The uses of mica, since it has been a commercial product, are as follows: At first it was used for window-glasses; at a later stage in its commercial history its use for lights was limited to the windows of men-of-war; this use continued down to the present day, but is now ceasing. Inquiry at the Charlestown navy-yard shows that some of it is in store there, but that it has not been put to use for many years. In the earlier stages of the glass- f making industry it was not easy to anneal plates so that they would stand any strong jarring motion; especially was the glass unfit for use when it was likely to receive the shock of artillery firing. This led to its rejection in men-of-war and to the substitution of mica. At present it appears that glass can be so much better annealed that it serves instead of mica in the few windows of our war ships. For a long time it was used in lanterns; this may, indeed, have been the first use to which it was put. I have been unable to ascertain that it is any longer used for this purpose. The smoke of a lantern more readily fouls the surface of mica plates than it does those of glass, and they are more difficult to cleanse, as their surfaces are less smooth than glass. The improvement in the annealing of glass has made it possible to make lanterns of it much more cheaply than those of mica. Owing to these changes in the art of glass-making, mica would no longer be produced for market were it not for the newly-invented fashion of placing plates of it in anthracite stoves so that the stove while air-tight may still show something of the cheerful

glow that comes from its fire. In this particular service mica is not replaceable by any other known substance. a Glass is too fusible as well as too brittle, while the mica is at once elastic and very durable. Even when so exposed as to be often heated to redness it will last for years without breaking down or entirely losing its transparency, and when destroyed it may be easily replaced. Mica plates only endure to advantage in stoves which make use of anthracitic coal; when bituminous coal is used the gases seem to be much more destructive to this substance Moreover, the soot gathers upon it and destroys the cheerful effect which it is the object of the stove-windows to afford. Despite the fact that the production of this substance does not rest upon any very wide basis of utility, for its present use is more of a fashion than a need, we fairly look forward to the continuance and increase of the demand. There has been a tolerably steady growth in this industry for many years. The annual production within the United States probably amounts to somewhere near 2 tons per week or about 100 tons per annum. The b total product is probably within somewhere near $500,000.

It is also reported that the waste clippings from the mica factories are used in a pulverized form in the manufacture of one of the forms of dynamite known as "rend rock", or "mica powder". For such a purpose the absorbent nature of its closely-adjacent plates would appear to fit it.

Mica has been extensively used as a lining for fire-proof safes in a finely-divided form. The abundant interspaces filled with air, and its resistance to high temperatures, makes it an excellent non-conductor when other substances would fuse with heat. It has also been proposed to use the waste clippings of mica factories for admixture with cast-iron in order to produce an anti-friction metal, but the utility of this process has never been demonstrated and seems very questionable. c

Sheet-mica has also been used for many less important purposes, a few of which we will note. It is now used in England to cover photographs, for which its tenuity and flexibility give it advantages over glass. In the Edison telephone it is used for vibrating plates, and the same inventor has used it as a substitute for glass in the reflectors of electric lamps. In the photophone it is used as a vibrating plate. A powder of mica is now used to give a shining surface to wall-paper, on which it is fixed by a gum. In the days of ancient Rome, powdered mica, and perhaps other substances of a somewhat similar nature, was scattered over the surfaces of amphitheaters to give them a pleasant aspect. The progress of the modern arts, both in the ways of utility and ornament, is constantly widening the demands for just such properties as are possessed by mica. Those properties are peculiar, and not readily or cheaply imitable. We may therefore expect that new uses for it will constantly be found. Professor Pumpelly has suggested to me the use of the colored micas in place of colored glass in decorated windows. The d colored micas which are chiefly of the biotite series, occur in great abundance in the Carolina mines. These mines are often very rich, and the actual cost of the small sheets should not be too great to enable it to compete with glass. I do not know whether it will endure the action of the weather so well as the colorless muscovite micas, which, judging from the conditions in natural exposures, would probably last quite as well as glass.

Although the regions known to contain workable mica are numerous, it must take rank among the rarer products of our American rocks. There has been a constant demand for the substance for many years, and many hundred prospects have been examined; still the price of the better kinds remains above that of any other mineral substance except the more precious metals and the gems. So far little skill has been applied to its mining. If the industry remains active long enough to permit a careful system of mining to be developed, there is reason to suppose that a larger product could be furnished at lower prices than those that now prevail. e

The distribution of the rocks which may afford supplies of this substance is such that the production will always be confined to somewhat narrow areas. In the region east of the Mississippi it is not likely that any profitable mines will be found save in the mountain ridges in the older parts of the Appalachian system. The granitic mountains of the Cordilleras of North America may furnish supplies of workable mica, but so far the great mountain system has not furnished anything to our markets.

I have been unable to determine the precise conditions that lead to the formation of large mica crystals in certain places, while in others this less common substance always remains in smaller aggregations. I am inclined to believe that it is in the main due to a freer molecular movement in certain rocks, owing to their more complete reduction to the state in which the molecules were free to group themselves together. The larger crystals are found in granites that seem clearly to have been completely fused, though some of our injected granites do not f show this peculiar feature. It may be worth while to note that our granites with large crystals of mica all occur in the centers of large areas of rocks of a granitic nature, and in the most disturbed part of the Laurentian chain. It may be that this position would be favorable to the more complete fusion of the rocks by heat and motion under pressure, and consequently to the more ready molecular aggregation of the particles. It should be said that large crystals of other kinds, beryls, etc., almost always accompany the development of mica in crystals of such size as to have a commercial value.

Although not prepared to explain the cause of this macrocrystalline character in certain granitic rocks, we may use it as a guide to plans where search may properly be made for mica in forms suitable for commercial uses. Wherever granitic rocks are observed to have the crystalline elements disposed in a large way, especially when the quartz element is not great in quantity, the feldspar in large crystals, and particularly if beryls abound in it,

a mica may reasonably be sought for. These indications are useful, as the mica is always much the least considerable part of the mass, and is often gathered into iron-like aggregations that do not appear on the outcrop. The best plan of exploration in New England, and generally in the Appalachian, is to cross-cut the surface where these conditions are found to occur by open trenches in the rock, extending the trenches at right-angles to the apparent stratification, or, if that be not discernible, from the west by north to the east by south, this direction being generally transverse to the run of the dikes, veins, or beds, if beds they be, in which this mica is contained.

The regions east of the Mississippi that appear to promise most for future search are western North and South Carolina, central Virginia, central, southern, and eastern New Hampshire. Of the Rocky Mountain region not enough is known to give a basis for any advice.

STATISTICS

OF THE

PRODUCTION OF MINOR MINERALS IN THE CENSUS YEAR.

TABLE 75.—*Statistics of the production of minor minerals, by states and counties.*

ASBESTOS.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT, CENSUS YEAR.	
							Tons.	Value.
Grand total		7	$10,000	*a*17	$1,400		150	$4,312
Georgia	Fulton	1	10,000	*a*2	250		25	750
Maryland	Baltimore	3		6	200		20	500
Do	Harford	1		2	100		20	500
Total		4		8	300		40	1,000
New York	Richmond	1		4	500		50	1,250
South Carolina	Pickens	1		3	350		35	1,312

a Includes 2 men employed below ground; all others are men employed above ground.

ASPHALTUM.

State.	County.	No. of mines.	Total hands employed.	Amount paid in wages.	PRODUCT, CENSUS YEAR.	
					Tons.	Value.
California	Los Angeles	1	8	$1,500	300	$3,000
Do	Santa Barbara	1	4	720	144	1,440
Total		2	12	2,220	440	4,440

BARYTES.

State.	County.	No. of mines.	Capital real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT, CENSUS YEAR.	
							Tons.	Value.
Grand total		6	$15,577	*a* 63	$7,802	$200	3,608	$37,491
Georgia	Bartow	1	1,000	4	160		200	2,000
Missouri	Washington	2					659	3,236
Pennsylvania	Franklin	1	1,377	*a* 10	642		285	855
Virginia	Pittsylvania	2	13,200	49	7,000	200	2,464	31,400

a Includes 2 boys employed above ground; all others are men employed above ground.

CHROMIC IRON.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			No. of drainage-machines.	No. of hoisting-machines.	Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines	Horse-power.					Tons.	Value.
Grand total		5	$176,000	*a* 43	$12,060	1	1	7	2	1	30	$160	2,563	$27,808
California	San Luis Obispo	2	75,000	*b* 16	6,000								2,153	15,508
Maryland	Baltimore	1	80,000	10	1,000	1	1	7	1	1		10	100	3,000
Do	Harford	1		5	200								10	300
Total		2	80,000	15	1,200	1	1	7	1	1		10	110	3,300
Pennsylvania	Lancaster	1	21,000	*c* 12	4,860				1		30	150	300	9,000

a Including 25 men employed below and 1 boy above ground; all others are men employed above ground.
b All employed below ground.
c Including 9 men employed below and 1 boy above ground.

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

COBALT.

State.	County.	No. of mines.	PRODUCT.	
			Tons.	Value.
Pennsylvania (a)	Lancaster	1	10,337	$5,169

a Included in nickel mined in Pennsylvania.

CORUNDUM (EMERY).

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			No. of drainage-machines.	No. of hoisting-machines.	Fuel, cords of wood.	Value of explosives.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines.	Horse-power.						Tons.	Value.
Grand total		3	$320,000	a 44	$11,601	2	2	16	3	3	465	$354	$4,997	1,044	$29,280
Massachusetts	Hampden	1	310,000	b 31	9,347	1	1	10	2	1	365	254	4,572	600	18,000
North Carolina	Macon	1		6	700									414	8,280
Do	Madison	1	10,000	c 7	1,554	1	1	6	1	2	100	100	425	30	3,000
Total		2	10,000	c 13	2,254	1	1	6	1	2	100	100	425	444	11,280

a Including 15 men employed below and 1 boy above ground; all others are men employed above ground.
b Including 11 men employed below and 1 boy above ground.
c Including 4 men below ground.

GARNET.

State.	County.	No. of mines.	Total hands employed.	Amount paid in wages.	PRODUCT.	
					Tons.	Value.
Pennsylvania	Delaware	1	2	$832	60	$1,200

GLASS SAND.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			No. of drainage-machines.	Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines.	Horse-power.				Tons.	Value.
Grand total		33	$250,100	a 332	$96,598	11	11	286	4	330	$11,997	125,052	$239,095
Illinois	La Salle	1	500	10	200							360	324
Indiana	Harrison	2	2,000	b 10	2,184				2			3,500	3,425
Do	Washington	1	1,500	c 10	1,658	1	1	4	1	40	90	2,924	3,216
Total		3	3,500	d 20	3,842	1	1	4	3	40	90	6,424	6,641
Maryland	Anne Arundel	3	52,000	56	12,255	3	4	85	1	80	1,905	17,125	34,250
Massachusetts	Berkshire	3	39,500	e 47	11,000	1	1	35		55	6,000	8,000	32,000
New Jersey	Camden	1	100	4	1,650						300	2,275	2,600
Do	Cumberland	4	21,900	32	8,830	1	1	10		75	136	16,500	18,575
Do	Gloucester	5	30,000	24	6,156					30	66	11,600	14,745
Do	Salem	1	3,000	4	1,040							3,120	2,340
Total		11	55,000	64	17,676	1	1	10		105	502	33,495	38,260
New York	Oneida	4	4,000	23	4,450							4,525	6,787
Do	Oswego	3	4,100	17	2,075							3,600	5,400
Total		7	8,100	40	6,525							8,125	12,187
Pennsylvania	Huntingdon	3	11,500	f 45	26,100	3	3	52				29,000	43,500
Do	Mifflin	2	80,000	50	19,000	2	1	100		50	3,500	22,523	71,933
Total		5	91,500	g 95	45,100	5	4	152		50	3,500	51,523	115,433

a Including 10 boys employed above ground.
b Including 1 boy employed above ground.
c Including 3 boys employed above ground.
d Including 4 boys employed above ground.
e Including 5 boys employed above ground.
f Including 1 boy employed above ground.
g Including 1 boy employed above ground.

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

GRAPHITE.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed	Amount paid in wages.	STEAM-POWER.			No. of drainage-machines.	No. of hoisting-machines.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines	Horse-power.				Tons.	Value.
Grand total		3	$280,000	a 93	$29,600	3	3	320	2	1	$2,900	940	$49,800
North Carolina	Wake	1	20,000	5	100							200	1,800
Pennsylvania		1	60,000	b 32	10,500	3	2	120	2	1	2,900	440	24,000
New York	Rensselaer	1	200,000	c 56	19,000		1	200				300	24,000

a Including 8 boys employed above ground; all others are men employed above ground.
b Including 2 boys employed above ground.
c Including 6 boys employed above ground.

HYDRAULIC CEMENT.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			No. of drainage-machines.	No. of hoisting-machines.	Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines.	Horse-power.					Barrels.	Value.
Grand total		28	$2,873,113	a 2,102	$750,367	62	36	3,445	1	2	2 362	$500,463	2,072,943	$1,852,707
Georgia	Bartow	1	10,000	25	4,800								10,000	12,500
Illinois	La Salle	2	400,000	150	78,000	4	3	100				5,000	120,000	102,000
Maryland	Alleghany	1	50,000	38	12,320	4	1	100			5	2,611	4,000	22,329
Do	Washington	1	25,000	30	8,959						10	7,770	21,794	19,615
Total		2	75,000	68	21,279	4	1	100			15	10,381	25,794	41,944
New York	Erie	3	300,000	b 190	54,500	7	6	340			225	18,500	262,084	238,007
Do	Onondaga	1	150,000	c 60	25,000	2	2	100					40,000	32,000
Do	Ulster	13	1,246,113	d 1,355	492,730	33	17	2,505	1	1	72	429,984	1,419,015	1,191,706
Total		17	1,696,113	e 1,605	572,230	42	25	2,945	1	1	297	448,484	1,721,099	1,461,713
Michigan	Kalamazoo	1	50,000	23	7,500	2	1	45			2,000		7,500	22,500
Pennsylvania	Lehigh	1	125,000	b 100	22,587	5	2	175		1	50	16,500	55,000	60,000
Do	Lawrence	1	150,000	c 45	14,150	3	2	80				12,623	25,000	43,500
Total		2	275,000	f 145	36,737	8	4	255		1	50	29,123	80,000	103,500
Virginia	Rockbridge	1	5,000	14	1,700								4,050	4,050
West Virginia	Jefferson	1	12,000	12	3,121							475	4,500	4,500
Wisconsin	Milwaukee	1	350,000	60	25,000	2	2					7,000	100,000	100,000

a Including 104 boys employed above ground; all others are men employed above ground.
b Including 10 boys employed above ground.
c Including 5 boys employed above ground.
d Including 74 boys employed above ground.
e Including 89 boys employed above ground.
f Including 15 boys employed above ground.

HYDRAULIC LIME.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines.	Horse-power.			Bushels.	Value.
New York	Onondaga	6	$93,000	100	$22,750	4	4	155	1,240	$28,500	749,932	$55,319

INFUSORIAL EARTH.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT.	
							Tons.	Value.
Grand total		2	$15,000	13	$1,381	$2,000	1,833	$45,660
Maryland	Calvert	1	10,000	10	1,331	2,000	1,800	45,000
New Jersey	Morris	1	5,000	3	50		33	660

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

KAOLIN.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER. No. of boilers.	No. of engines.	Horse-power.	No. of drainage-machines.	Fuel, cords of wood.	Total value of all materials.	PRODUCT. Tons.	Value.
Grand total		9	$436,075	*a* 283	$85,150	9	8	351	13	100	$25,285	23,277	$200,457
Delaware	New Castle	4	285,000	186	62,000	7	6	301	13		21,000	14,510	163,310
Indiana	Lawrence	1	52,000	*b* 11	4,900					100	500	1,000	8,000
Maryland	Cecil	1	50,000	16	250	1	1	8			100	250	1,750
New York	Dutchess	1	4,075	*b* 16	2,400	1	1	42			185	125	1,000
South Carolina	Aiken	2	45,000	60	15,600						3,500	7,392	26,397

a Including 12 men employed below and 4 boys above ground; all others are men employed above ground.
b Including 6 men employed below and 2 boys above ground.

MAGNESIAN LIMESTONE.

State.	County.	No. of mines.	Total hands employed.	Amount paid in wages.	STEAM-POWER. No. of boilers.	No. of engines.	Horse-power.	No. of hoisting-machines.	Cords of wood consumed.	Total value of all materials.	PRODUCT. Barrels.	Value.
Grand total		2	80	$16,500	1	1	40	1	2,250	$3,000	63,000	$44,175
Georgia	Bartow	1	20	6,000						2,250	15,000	12,000
Do	Catoosa	1	60	10,500	1	1	40	1	2,250	750	48,000	32,175

MANGANESE.

State.	County.	No. of mines.	CAPITAL. Real estate.	Plant, etc.	Working capital.	Total.	EMPLOYÉS. Men above ground.	Boys above ground.	Men below ground.	Total.	Miners.	Laborers.	Administrative force.	Amount paid in wages.	Total value of machinery.
Grand total		6	$43,600	$14,500	$13,700	$71,800	147	20	65	232	120	102	10	$46,610	$10,500
Georgia	Bartow	1	8,000	10,000	2,000	20,000	100			100	70	25	5	24,000	8,500
Virginia	Augusta	1				39,000	10	10	35	55				10,000	
Do	Campbell	2				600	10			10				700	
Do	Shenandoah	2				12,200	27	10	30	67				11,910	
Total		5	35,600	4,500	11,700	51,800	47	20	65	132	50	77	5	22,610	2,000

State.	County.	No. of drainage-machines.	No. of hoisting-machines.	STEAM-POWER. No. of engines.	Value.	Horse-power.	No. of boilers.	Value.	Horse-power.	No. of horses.	Value.	No. of mules.	Value.	FUEL. Cords of wood.	Value.
Grand total		3	3	3	$3,650	87	3	$1,800	115	21	$1,980	7	$700	750	$937
Georgia	Bartow			2	3,000	75	2	1,500	100	15	1,500				
Virginia	Augusta	3	3	1		12	1							750	
Do	Campbell														
Do	Shenandoah														
Total		3	3	1	650	12	1	300	15	6	480	7	700	750	937

State.	County.	LUMBER. Unsawed, feet, linear measure.	Value.	Sawed feet, board-measure.	Value.	Value of explosives.	Total value of all materials.	PRODUCT. Tons.	Value.
Grand total		120,000	$468	690,000	$2,646	$300	$11,813	*a*10,713	$96,935
Georgia	Bartow					200	6,000	6,720	60,000
Virginia	Augusta						5,443	3,050	27,230
Do	Campbell						100	235	2,625
Do	Shenandoah						270	708	7,080
Total		120,000	468	600,000	2,646	100	5,813	*a*3,993	36,935

a Besides 637 tons without details as to mines, etc.

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

MICA.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER. No. of boilers.	STEAM-POWER. No. of engines.	Value of explosives.	PRODUCT. Pounds.	PRODUCT. Value.
Total		22	$337,900	*a* 272	$65,600	1	1	$6,110	81,669	$127,825
Maine	Oxford	1	12,000	6	1,350			120	2,000	2,000
Massachusetts	Hampden	1	5,000	25	750			600	1,000	1,250
New Hampshire	Grafton	3	314,000	*b* 64	33,850			1,950	36,000	62,900
North Carolina	Haywood	1		5	750			35	1,000	8,000
Do	Jackson	3		8	1,040			78	1,300	1,700
Do	McDowell	1		9	400			34	500	750
Do	Macon	2		*c* 11	3,100			1,050	6,000	9,000
Do	Mitchell	3	5,900	*d* 127	22,210	1	1	2,119	30,942	37,775
Do	Yancy	2	1,000	17	2,150			124	2,927	4,450
Total		17	6,900	*e* 177	29,650	1	1	3,440	42,669	61,675

a Includes 52 men employed below and 20 boys employed above ground, all others being men employed above ground.
b Includes 16 boys employed above ground.
c Includes 8 men employed below ground.
d Includes 44 men employed below and 4 boys employed above ground.
e Includes 52 men employed below and 4 boys employed above ground.

MINERAL SOAP.

State.	County.	No. of mines.	Total hands employed.	Product, tons.
Nevada	Elko	1	*a* 2	50

a Men employed below ground.

NICKEL.

State.	County.	No. of mines.	CAPITAL. Real estate.	CAPITAL. Plant, etc.	CAPITAL. Working capital.	CAPITAL. Total.	EMPLOYÉS. Men above ground.	EMPLOYÉS. Boys above ground.	EMPLOYÉS. Men below ground.	EMPLOYÉS. Total.	EMPLOYÉS. Miners.	EMPLOYÉS. Laborers.	EMPLOYÉS. Administrative force.	Amount paid in wages.	No. of hoisting-machines.
Grand total		4	$207,500	$115,000	$27,000	$349,500	30	4	36	70	44	24	2	$24,500	1
Massachusetts	Middlesex	1	7,500	15,000	2,000	24,500	10			10	10			5,500	1
Missouri	Madison	1													
Do	Saint François	1													
Total		2													
Pennsylvania	Lancaster	1	200,000	100,000	25,000	325,000	20	4	36	60	34	24	2	19,000	

State.	County.	STEAM-POWER. No. of engines.	STEAM-POWER. Value.	STEAM-POWER. Horse-power.	STEAM-POWER. No. of boilers.	STEAM-POWER. Value.	STEAM-POWER. Horse-power.	No. of horses.	Value.	LUMBER. Unsawed, feet, linear measure.	LUMBER. Value.	Value of explosives.	PRODUCT. Pounds.	PRODUCT. Value.
Grand total		4	$20,500	155	4	$2,400	203	8	$1,200	30,000	$600	$630	329,968	$164,984
Massachusetts	Middlesex	1	500	25	1	400	43					30	13,440	6,720
Missouri	Madison													5,514
Do	Saint François													2,860
Total													*a* 16,748	8,374
Pennsylvania	Lancaster	3	20,000	130	3	2,000	160	8	1,200	30,000	600	600	299,780	149,890

a The quantity of nickel given is the estimated yield of 58,293 pounds of nickel matte, of which 38,293 pounds were reported from Madison county and 20,000 pounds from Saint François county.

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

NICKEL AND COBALT MATTE.

State.	County.	No. of mines.	PRODUCT.	
			Pounds.	Value.
Missouri	Saint François	1	11,332	$1,586

OCHER.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of engines.	No. of boilers.	Horse-power.			Tons.	Value.
Grand total		7	$161,050	a 100	$24,396	6	7	158	1,230	$1,890	4,037	$135,840
New Jersey	Monmouth	1	5,000	3	600						300	1,350
Vermont	Rutland	3	115,000	52	10,096	4	5	100	530	1,775	1,750	27,750
Virginia	Page	1	25,000	7	2,600	1	1	18	300	100	875	82,500
Do	Rockingham	1	4,050	8	600					15	112	2,240
Do	Chesterfield	1	32,000	a 30	10,500	1	1	40	400		1,000	22,000
Total		3	61,050	a 45	13,700	2	2	58	700	115	1,987	106,740

a Including 5 men employed below ground; all others are men employed above ground.

OIL-STONE.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of engines.	No. of boilers.	Horse-power.			Pounds.	Value.
Indiana	Orange	3	$3,500	8	$2,590	1	1	10	100	$110	200,000	$5,350

PYRITE (FOR SULPHURIC ACID).

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT.	
							Tons.	Value.
New York	Saint Lawrence	1	$10,550	a 6	$1,200	$365	2,240	$5,000

a Including 3 men employed below ground; all others are men employed above ground.

QUARTZ AND FELDSPAR.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.			Cords of wood consumed.	Total value of all material.	PRODUCT.	
						No. of boilers.	No. of engines.	Horse-power.			Tons.	Value.
Grand total		14	$540,450	119	$38,667	2	2	28	1,138	$13,167	21,571	$103,878
Maryland	Cecil	1	25,000	19	3,875				325	1,035	1,475	10,325
Do	Harford	4	80,000	3	9,040	1	1	20	813	9,603	2,551	19,784
Total		5	105,000	22	12,915	1	1	20	1,138	10,638	4,026	30,109
Massachusetts	Hampden	2	254,000	23	12,300					1,600	3,400	44,000
Michigan	Marquette	2	4,250	45	8,000						8,738	18,557
New Hampshire	Sullivan	1	125,000	12	2,100					700	3,500	3,400
New York	Washington	4	52,200	17	3,352	1	1	8		229	1,907	7,812

TABLE 75.—*Statistics of the production of minor minerals, by states and counties*—Continued.

SCYTHE-STONES.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	PRODUCT.	
						Gross.	Value.
Grand total		4	$6,700	17	$2,178	5,675	$19,638
New Hampshire	Grafton	1	2,000	7	900	5,000	16,250
Vermont	Washington	2	3,700	4	478	175	1,763
Do	Windsor	1	1,000	6	800	500	1,625
Total		3	4,700	10	1,278	675	3,388

SHOEMAKERS' SANDSTONES.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	PRODUCT.	
						Pounds.	Value.
Indiana	Orange	2	$1,000	*a* 4	$1,500	150,000	$2,300

a Including 2 boys employed above ground.

SOAPSTONE.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	STEAM-POWER.		Fuel, cords of wood.	Total value of all materials.	PRODUCT.	
						No. of boilers.	No. of engines.			Tons.	Value.
Grand total		11	$202,900	*a* 113	$29,455	2	2	300	$2,841	8,441	$66,665
Georgia	Cherokee	1	1,400	8	300				100	200	500
Do	Murray	1	6,000	4	90					120	210
Total		2	7,400	12	390				100	320	710
Maryland	Baltimore	1	12,000	4	734				114	300	1,950
New Hampshire	Hillsborough	1	100,000	30	12,000	1	1	300	950	2,000	30,000
North Carolina	Cherokee	1	2,500	10	2,200					450	4,500
Do	Swain	1	2,500	5	300					60	600
Total		2	5,000	15	2,500					510	5,100
Pennsylvania	Franklin	1	10,000	*a* 6	1,650				150	11	55
Do	Montgomery	1	37,000	21	6,281	1	1		402	4,000	17,000
Total		2	47,000	*a* 27	7,931	1	1		552	4,011	17,055
Vermont	Windham	2	25,500	19	5,100				625	900	7,850
Do	Windsor	1	6,000	6	800				500	400	4,000
Total		3	31,500	25	5,900				1,125	1,300	11,850

a Includes 6 men employed below ground, all others being men employed above ground.

TALC.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT.	
							Tons.	Value.
New York	Saint Lawrence	3	$24,100	65	$28,090	$15,360	4,210	$54,730

WHETSTONE.

State.	County.	No. of mines.	Capital, real and personal.	Total hands employed.	Amount paid in wages.	Total value of all materials.	PRODUCT.	
							Gross.	Value.
Vermont	Orleans	2	$74,000	10	$2,175	$300	2,900	$5,800

TABLE 76.—*Statistics of the production of minor minerals, by states.*

[A summary of Table 75.]

ASBESTOS.

	States.	Number of counties.	Number of mines.	Total marketable product for census year, tons (unless otherwise specified).	Value.	EMPLOYÉS. Number of men below ground.	Number of boys below ground.	Number of men above ground.	Number of boys above ground.	Total number of employés.	Number of miners.	Number of laborers.	Administrative force.	Total wages paid.	CAPITAL. Real estate.	Plant.	Working capital.	Total capital.	Value of materials used.	Total value of machinery.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	5	7	150	$4,312	2	....	15	....	17	....	....	....	$1,400	.....	.....	.....	.....	.....	.....
1	Georgia	1	1	25	750	2	....	.....	....	2	....	....	....	250	.....	.....	.....	.....	.....	.....
2	Maryland	2	4	40	1,000	....	....	8	....	8	....	....	....	300	.....	.....	.....	.....	.....	.....
3	New York	1	1	50	1,250	....	....	4	....	4	....	....	....	500	.....	.....	.....	.....	.....	.....
4	South Carolina	1	1	35	1,312	....	....	3	....	3	....	....	....	350	.....	.....	.....	.....	.....	.....

ASPHALTUM.

	Total	2	2	444	$4,440	....	....	12	....	12	....	....	....	$2,220	.....	.....	.....	.....	.....	.....
1	California	2	2	444	4,440	....	....	12	....	12	....	....	....	2,220	.....	.....	.....	.....	.....	.....

BARYTES.

	Total	4	6	3,608	$37,491	....	....	61	2	63	....	....	....	$7,802	.....	.....	.....	$15,577	$200	.....
1	Georgia	1	1	200	2,000	....	....	4	....	4	....	....	....	160	.....	.....	.....	1,000	.....	.....
2	Pennsylvania	1	1	285	855	....	....	8	2	10	....	....	....	642	.....	.....	.....	1,377	.....	.....
3	Virginia	1	2	2,464	31,400	....	....	49	....	49	....	....	....	7,000	.....	.....	.....	13,200	200	.....
4	Missouri	1	2	659	3,236	....	....	.....	....	.....	....	....	....	.....	.....	.....	.....	.....	.....	.....

CHROMIC IRON.

	Total	4	5	2,563	$27,808	25	....	17	1	43	....	....	....	$12,060	.....	.....	.....	$176,000	$160	.....
1	California	1	2	2,153	15,508	16	....	.....	....	16	....	....	....	6,000	.....	.....	.....	75,000	.....	.....
2	Maryland	2	2	110	3,300	....	....	15	....	15	....	....	....	1,200	.....	.....	.....	80,000	10	.....
3	Pennsylvania	1	1	300	9,000	9	....	2	1	12	....	....	....	4,860	.....	.....	.....	21,000	150	.....

COBALT (SEE ALSO NICKEL AND COBALT).

	Total	1	1	10,337	$5,169	....	....	.....	....	.....	....	....	....	.....	.....	.....	.....	.....	.....	.....
1	Pennsylvania	1	1	10,337	5,169	....	....	.....	....	.....	....	....	....	.....	.....	.....	.....	.....	.....	.....

CORUNDUM.

	Total	3	3	1,044	$29,280	15	....	28	1	44	....	....	....	$11,601	.....	.....	.....	$320,000	$4,997	.....
1	Massachusetts	1	1	600	18,000	11	....	19	1	31	....	....	....	9,347	.....	.....	.....	310,000	4,572	.....
2	North Carolina	2	2	444	11,280	4	....	9	....	13	....	....	....	2,254	.....	.....	.....	10,000	425	.....

GARNET.

	Total	1	1	60	$1,200	....	....	2	....	2	....	....	....	$832	.....	.....	.....	.....	.....	.....
1	Pennsylvania	1	1	60	1,200	....	....	2	....	2	....	....	....	832	.....	.....	.....	.....	.....	.....

TABLE 76.—*Statistics of the production of minor minerals, by states.*

[A Summary of Table 75.]

Number of cords of wood used annually.	Value.	Unsawed lumber (other than for fuel).	Value.	Sawed lumber, feet, board measure.	Value.	Number of horses.	Value.	Number of mules.	Value.	STEAM-POWER. Number of steam-engines.	Value.	Horse-power of steam-engines.	Number of boilers.	Value.	Horse-power.	Cost of explosives.	Number of hoisting-machines.	Number of drainage-machines.	Remarks.	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
		Lin. ft.																		
ASBESTOS.																				
																				1
																				2
																				3
																				4
ASPHALTUM.																				
																				1
BARYTES.																				
																				1
																				2
																				3
																				4
CHROMIC IRON.																				
30										1		7	1				1	2		
																				1
										1		7	1				1	1		2
30																		1		3
COBALT (SEE ALSO NICKEL AND COBALT).																				
																				1
CORUNDUM.																				
465										2		16	2			$354	3	3		
365										1		10	1			254	1	2		1
100										1		6	1			100	2	1		2
GARNET.																				
																				1

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

GLASS SAND.

	States.	Number of counties.	Number of mines.	Total marketable product for census year, tons, (unless otherwise specified).	Value.	EMPLOYÉS. Number of men below ground.	Number of boys below ground.	Number of men above ground.	Number of boys above ground.	Total number of employés.	Number of miners.	Number of laborers.	Administrative force.	Total wages paid.	CAPITAL. Real-estate.	Plant.	Working capital.	Total capital.	Value of materials used.	Total value of machinery.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	13	33	125,052	$239,095			322	10	332				$96,598				$250,100	$11,997	
1	Illinois	1	1	360	324			10		10				200				500		
2	Indiana	2	3	6,424	6,641			16	4	20				3,842				3,500	90	
3	Maryland	1	3	17,125	34,250			56		56				12,255				52,000	1,905	
4	Massachusetts	1	3	8,000	32,000			42	5	47				11,000				39,500	6,000	
5	New Jersey	4	11	33,495	38,260			64		64				17,676				55,000	502	
6	New York	2	7	8,125	12,187			40		40				6,525				8,100		
7	Pennsylvania	2	5	51,523	115,433			94	1	95				45,100				91,500	3,500	

GRAPHITE.

	Total	3	3	940	$49,800			85	8	93				$29,600				$280,000	$2,900	
1	New York	1	1	300	24,000			50	6	56				19,000				200,000		
2	North Carolina	1	1	200	1,800			5		5				100				20,000		
3	Pennsylvania	1	1	440	24,000			30	2	32				10,500				60,000	2,900	

HYDRAULIC CEMENT.

	Total	13	28	a 2,072,943	$1,852,707			1,998	104	2,102				$750,367				$2,873,113	$500,463	
1	Georgia	1	1	10,000	12,500			25		25				4,800				10,000		
2	Illinois	1	2	120,000	102,000			150		150				78,000				400,000	5,000	
3	Maryland	2	2	25,794	41,944			68		68				21,279				75,000	10,381	
4	Michigan	1	1	7,500	22,500			23		23				7,500				50,000		
5	New York	3	17	1,721,099	1,461,713			1,516	89	1,605				572,230				1,696,113	448,484	
6	Pennsylvania	2	2	80,000	103,500			130	15	145				36,737				275,000	29,123	
7	Virginia	1	1	4,050	4,050			14		14				1,700				5,000		
8	West Virginia	1	1	4,500	4,500			12		12				3,121				12,000	475	
9	Wisconsin	1	1	100,000	100,000			60		60				25,000				350,000	7,000	

HYDRAULIC LIME.

	Total	1	6	b 749,932	$55,319			100		100				$22,750				$93,000	$28,500	
1	New York	1	6	749,932	55,319			100		100				22,750				93,000	28,500	

INFUSORIAL EARTH.

	Total	2	2	1,833	$45,660			13		13				$1,381				$15,000	$2,000	
1	Maryland	1	1	1,800	45,000			10		10				1,331				10,000	2,000	
2	New Jersey	1	1	33	660			3		3				50				5,000		

KAOLIN.

	Total	5	9	23,277	$200,157	12		267	4	283				$85,150				$436,075	$25,285	
1	Delaware	1	4	14,510	163,310			186		186				62,000				285,000	21,000	
2	Indiana	1	1	1,000	8,000	6		3	2	11				4,900				52,000	500	
3	Maryland	1	1	250	1,750			10		10				250				50,000	100	
4	New York	1	1	125	1,000	6		8	2	16				2,400				4,075	185	
5	South Carolina	1	2	7,392	26,397			60		60				15,600				45,000	3,500	

a Barrels. *b* Bushels.

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

GLASS SAND.

Number of cords of wood used annually.	Value.	Unsawed lumber (other than for fuel).	Value.	Sawed lumber, feet, board measure.	Value.	Number of horses.	Value.	Number of mules.	Value.	STEAM-POWER. Number of steam-engines.	Value.	Horse-power of steam-engines.	Number of boilers.	Value.	Horse-power.	Cost of explosives.	Number of hoisting-machines.	Number of drainage-machines.	Remarks.	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
330										11		286	11					4		
																				1
40										1		4	1					3		2
80										4		85	3					1		3
55										1		35	1							4
105										1		10	1							5
																				6
50										4		152	5							7

GRAPHITE.

										3		320	3				1	2	Exclusive of returns from Dixon Crucible Company, which were received too late for tabulation.	
										1		200								1
																				2
										2		120	3				1	2		3

HYDRAULIC CEMENT.

2,362										36		3,445	62				2	1	Exclusive of returns from Howe's Cave Lime and Cement Company and Howe's Cave Association, as no answers to the schedules were received from them.	
																				1
										3		100	4							2
15										1		100	4							3
2,000										1		45	2							4
297										25		2,945	42				1	1		5
50										4		255	8				1			6
																				7
																				8
										2			2							9

HYDRAULIC LIME.

1,240										4		155	4							
1,240										4		155	4							1

INFUSORIAL EARTH.

																				1
																				3

KAOLIN.

100										8		351	9			20		13		
										6		301	7					13		1
100																				2
										1		8	1							3
										1		42	1			20				4
																				5

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

MAGNESIAN LIMESTONE.

	States.	Number of counties.	Number of mines.	Total marketable product for census year, tons (unless otherwise specified).	Value.	EMPLOYÉS. Number of men below ground.	Number of boys below ground.	Number of men above ground.	Number of boys above ground.	Total number of employés.	Number of miners.	Number of laborers.	Administrative force.	Total wages paid.	CAPITAL. Real-estate.	Plant.	Working capital.	Total capital.	Value of materials used.	Total value of machinery.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	2	2	a63,000	$44,175	....	....	80	....	80	....	....	....	$16,500	.....	.....	.....	.....	$3,000	.....
1	Georgia	2	2	63,000	44,175	....	....	80	....	80	....	....	....	16,500	.....	.....	.....	.....	3,000	.....

MANGANESE.

	Total	4	6	10,713	$96,935	65	....	147	20	232	120	102	10	$46,610	$43,600	$14,500	$13,700	$71,800	$11,813	$10,500
1	Georgia	1	1	6,720	60,000	....	..	100	...	100	70	25	5	24,000	8,000	10,000	2,000	20,000	6,000	8,500
2	Virginia	3	5	3,993	36,935	65	....	47	20	132	50	77	5	22,610	35,600	4,500	11,700	51,800	5,813	2,000

MICA.

	Total	9	22	b81,669	$127,825	52	....	200	20	272	....	....	....	$65,600	.....	.....	.....	$337,900	.....	.....
1	Maine	1	1	2,000	2,000	....	....	6	...	6	....	....	....	1,350	.....	.....	.....	12,000	.....	.....
2	Massachusetts	1	1	1,000	1,250	...	....	25	..	25	....	....	....	750	.....	.....	.....	5,000	.....	.....
3	New Hampshire	1	3	36,000	62,900	....	....	48	16	64	....	....	...	33,850	.....	.....	.....	314,000	.....	.....
4	North Carolina	6	17	42,669	61,675	52	...	121	4	177	....	...	....	29,650	.....	.....	.....	6,900	.....	.....

MINERAL SOAP.

	Total	1	1	50	.....	2	...	.....	..	2	...	....	....	.....	.....	.....	.....	.....	.....	.....
1	Nevada	1	1	50	.....	2	....	.....	....	2	...	....	....	.....	.....	.....	.....	.....	.....	.....

NICKEL.

	Total	4	4	b329,968	$164,984	36	....	30	4	70	44	24	2	$24,500	$207,500	$115,000	$27,000	$349,500	.....	.....
1	Massachusetts	1	1	13,440	6,720	....	....	10	....	10	10	....	....	5,500	7,500	15,000	2,000	24,500	.....	.....
2	Missouri	2	2	16,748	8,374	....	....	.....	....	.....	....	....	....	.....	.....	.....	.....	.....	.....	.....
3	Pennsylvania	1	1	299,780	149,890	36	....	20	4	60	34	24	2	19,000	200,000	100,000	25,000	325,000	.....	.....

NICKEL AND COBALT.

	Total	1	1	b11,332	$1,586	....	....	.....	...	.....	....	....	...	.....	.....	.....	.....	.....	.....	.....
1	Missouri	1	1	11,332	1,586	....	....	.....	....	.....	....	...	...	.....	.....	.....	.....	.....	.....	.....

OCHER.

	Total	5	7	4,037	$135,840	5	....	95	....	100	....	....	....	$24,396	.....	.....	.....	$181,050	$1,890	.....
1	New Jersey	1	1	300	1,350	....	....	3	....	3	....	....	...	600	.....	.....	.....	5,000	.....	.....
2	Vermont	1	3	1,750	27,750	....	....	52	...	52	....	....	....	10,096	.....	.....	.....	115,000	1,775	.....
3	Virginia	3	3	1,987	106,740	5	....	40	....	45	....	....	...	13,700	.....	.....	.....	61,050	115	.....

OIL-STONE.

	Total	1	3	b200,000	$5,350	....	...	8	....	8	....	....	....	$2,590	.....	.....	.....	$3,500	$110	.....
1	Indiana	1	3	200,000	5,350	...	...	8	....	8	....	...	....	2,590	.....	.....	.....	3,500	110	.....

a Barrels. b Pounds.

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

Number of cords of wood used used annually.	Value.	Unsawed lumber (other than for fuel).	Value.	Sawed lumber, feet, board measure.	Value.	Number of horses.	Value.	Number of mules.	Value.	STEAM-POWER. Number of steam-engines.	Value.	Horse-power of steam-engines.	Number of boilers.	Value.	Horse-power.	Cost of explosives.	Number of hoisting-machines.	Number of drainage-machines.	Remarks.	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
		Lin. ft.																		
2,250										1		40	1				1			
2,250										1		40	1				1			1
MANGANESE.																				
750	$937	120,000	$468	690,000	$2,646	21	$1,980	7	$700	3	$3,650	87	3	$1,800	115	$300	3	3	Exclusive of 637 tons reported without details as to mining, etc.	
						15	1,500			2	3,000	75	2	1,500	100	200				1
750	937	120,000	468	690,000	2,646	6	480	7	700	1	650	12	1	300	15	100	3	3		2
MICA.																				
										1			1			6,110			There are a few mica mines in Virginia or West Virginia from which no returns have been received.	
																120				1
																600				2
																1,950				3
										1			1			3,440				4
MINERAL SOAP.																				
																				1
NICKEL.																				
		30,000	$600			8	$1,200			4	$20,500	155	4	$2,400	203	$630	1			
										1	500	25	1	400	43	30	1			1
																				2
		30,000	600			8	1,200			3	20,000	130	3	2,000	160	600				3
NICKEL AND COBALT.																				
																				1
OCHER.																				
1,230										7		158	6						There are a few ocher mines in Virginia or West Virginia from which no returns have been received.	
																				1
530										5		180	4							2
700										2		58	2							3
OIL-STONE.																				
100										1		10	1							
100										1		10	1							1

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

PYRITE.

	States.	Number of counties.	Number of mines.	Total marketable product for census year, tons (unless otherwise specified).	Value.	EMPLOYES. Number of men below ground.	Number of boys below ground.	Number of men above ground.	Number of boys above ground.	Total number of employés.	Number of miners.	Number of laborers.	Administrative force.	Total wages paid.	CAPITAL. Real-estate.	Plant.	Working capital.	Total capital.	Value of materials used.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Total	1	1	2,240	$5,000	3	....	3	....	6	....	....	....	$1,200	....	....	....	$10,550	$365
1	New York	1	1	2,240	5,000	3	....	3	....	6	....	....	....	1,200	....	....	....	10,550	365

QUARTZ.

	Total	6	14	21,571	$103,878	....	....	119	....	119	....	....	....	$38,667	....	....	....	$540,450	$13,167
1	Maryland	2	5	4,026	30,109	....	....	22	....	22	....	....	....	12,915	....	....	....	105,000	10,638
2	Massachusetts	1	2	3,400	44,000	....	....	23	....	23	....	....	....	12,300	....	....	....	254,000	1,600
3	Michigan	1	2	8,738	18,557	....	....	45	....	45	....	....	....	8,000	....	....	....	4,250	....
4	New Hampshire	1	1	3,500	3,400	....	....	12	....	12	....	....	....	2,100	....	....	....	125,000	700
5	New York	1	4	1,907	7,812	....	....	17	....	17	....	....	....	3,352	....	....	....	52,200	229

SCYTHE-STONE.

	Total	3	4	*a* 5,675	$19,638	....	....	17	....	17	....	....	....	$2,178	....	....	....	$6,700	....
1	New Hampshire	1	1	5,000	16,250	....	....	7	....	7	....	....	....	900	....	....	....	2,000	....
2	Vermont	2	3	675	3,388	....	....	10	....	10	....	....	....	1,278	....	....	....	4,700	....

SHOEMAKER'S SANDSTONE.

	Total	1	2	*b* 150,000	$2,300	....	....	2	2	4	....	....	....	$1,500	....	....	....	$1,000	....
1	Indiana	1	2	150,000	2,300	....	....	2	2	4	....	....	....	1,500	....	....	....	1,000	....

SOAPSTONE.

	Total	10	11	8,441	$66,665	6	....	107	....	113	....	....	....	$29,455	....	....	....	$202,900	$2,841
1	Georgia	2	2	320	710	....	....	12	....	12	....	....	....	390	....	....	....	7,400	100
2	Maryland	1	1	300	1,950	....	....	4	....	4	....	....	....	734	....	....	....	12,000	114
3	New Hampshire	1	1	2,000	30,000	....	....	30	....	30	....	....	....	12,000	....	....	....	100,000	950
4	North Carolina	2	2	510	5,100	....	....	15	....	15	....	....	....	2,500	....	....	....	5,000	....
5	Pennsylvania	2	2	4,011	17,055	6	....	21	....	27	....	....	....	7,931	....	....	....	47,000	552
6	Vermont	2	3	1,300	11,850	....	....	25	....	25	....	....	....	5,900	....	....	....	31,500	1,125

TALC.

	Total	1	3	4,210	$54,730	....	....	65	....	65	....	....	....	$28,090	....	....	....	$24,100	$15,360
1	New York	1	3	4,210	54,730	....	....	65	....	65	....	....	....	28,090	....	....	....	24,100	15,360

WHETSTONE.

	Total	1	2	*a* 2,900	$5,800	....	....	10	....	10	....	....	....	$2,175	....	....	....	$74,000	$300
1	Vermont	1	2	2,900	5,800	....	....	10	....	10	....	....	....	2,175	....	....	....	74,000	300

a Gross. *b* Pounds.

TABLE 76.—*Statistics of the production of minor minerals, by states*—Continued.

Amount of wood used annually.	Value.	Unsawed lumber (other than for fuel).	Value.	Sawed lumber, feet, board measure.	Value.	Number of horses.	Value.	Number of mules.	Value.	STEAM-POWER. Number of steam-engines.	Value.	Horse-power of steam-engines.	Number of boilers.	Value.	Horse-power.	Cost of explosives.	Number of hoisting-machines.	Number of drainage-machines.	Remarks.	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38		
		Lin. ft.																		
																				1
PYRITE.																				
QUARTZ.																				
138										2		28	2							
138										1		20	1							1
																				2
																				3
																				4
										1		8	1							5
SCYTHE-STONE.																				
																			The value of the product is of the manufactured article. The cost of "manufacturing" does not appear under "Wages."	1
																				2
SHOEMAKER'S SANDSTONE.																				
																				1
SOAPSTONE.																				
300										2			2							
																				1
																				2
300										1			1							3
																				4
										1			1							5
																				6
TALC.																				
																				1
WHETSTONE.																				
																				1

DIRECTORY

OF

MINES AND METALLURGICAL ESTABLISHMENTS

EAST OF 100TH MERIDIAN,

AND OF THE MINES OF BITUMINOUS COAL AND LIGNITE IN THE WESTERN STATES AND TERRITORIES.

DIRECTORY OF MINES AND METALLURGICAL ESTABLISHMENTS.

Directory of anthracite coal mines.

PENNSYLVANIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds). (a)	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CARBON COUNTY.			*Feet.*		
No. 3 mine, Primrose and Mammoth seams.	Nesquehoning	Lehigh Coal and Nav. Co.	99,327	16-24 24-40	Anthracite	N. Y. and Phila., via C. R. R. of N. J. and L. C. and Nav. Co's canals.
No. 4 mine, Mammoth seam	Panther Creek valley	do	None	40	do	Do.
No. 5 mine, Mammoth seam	Andrewsville	do	56,371	20	do	Do.
No. 6 mine, Primrose and Mammoth seams.	do	do	93,053	8 37	do	Do.
No. 9 mine, Primrose and Mammoth seams.	Lansford	do	141,448	40	do	Do.
Honey Brook Colliery No. 2, Wharton seam.	Tresckow	Lehigh and Wilkes-Barre C. Co.	111,640	6	Anthracite, hard white ash	N. Y. and Phila. and L. V. f'ces and C. R. R. of N. J., via C. R. R. of N. J. and L. and Del. Div. canals.
Yorktown mine, Wharton and Mammoth seams.	Audenreid	Thomas John & Co	152,182	8½ 24	Anthracite, hard white ash, best domestic and steam.	Phila., N. Y. and L. V. f'ces., via L. Val. R. R., N. J. C. R. R. and Lehigh Canal.
Coleraine mine, Wharton and Mammoth seams.	Beaver Meadow	Chas. F. Shoener	153,451	25	Anthracite, hard white ash	N. Y. and Phila., via L. V. R. R., N. Pa. R. R. and Lehigh Canal.
	COLUMBIA COUNTY.					
Hazel Dell mine, Buck Mountain seam.	Centralia	Sykes & Jones	15,680	11	Anthracite, hard white ash	Perth Amboy, N. J., N. Y. and P. and R. line, via L. Valley and Phila. R. R.
Glen City Colliery, Buck Mountain seam.	Glen City	J. A. Losee	27,803	10-11	Anthracite	Erie, Pa., and places along line, via Sunbury, Hazleton and Wilkes-Barre R. R. and P. and E. R. R.
Monroe mine, Skidmore seam	Montana	A. H. Church	11,591	18	Anthracite, white ash	
J. L. Kline mine	do	J. L. Kline	2,240	------	Anthracite	Neighboring towns.
Miller, Ruff & Beaver mine		Miller, Ruff & Beaver				
Piffer & Geraphy mine	Centralia	Piffer & Geraphy				
Continental Colliery, Mammoth seam.	do	Lehigh Valley Coal Co.	127,755	26	do	Perth Amboy, via L. V. R. R.
Potts mine, Mammoth seam	Conyngham township	Phila. and Reading C. and I. Co.	97,104	22	Anthracite, hard white ash	P. and R. R. R., Schuyl. Can., Susquehanna Can to the lakes, Phila. and Erie R. R.
Keystone mine, Mammoth seam.	do	do	36,400	22	Anthracite, white ash, free-burning.	Do.
	DAUPHIN COUNTY.					
Williamstown mine, Lykens Valley seam.	Williamstown	Summit Branch R. R. Co.	281,867	7	Anthracite, red ash	Phila., Balt., and the East, via Summit Branch R. R., North. Cen. R. R., and Penna. R. R.
Short Mountain mine, Lykens Valley seam.	Wiconisco	Lykens Valley Coal Co.	168,478	9	Semi anthracite, red ash	Do.
	LACKAWANNA COUNTY.					
Anthracite mine, Nos. 1 and 2 seams.	Old Forge	Anthracite Coal Co	62,905	9	Anthracite, hard, free-burning.	N. Y., via Del., Lacka., and West. R. R.
Greenwood mine, Nos. 1, 3, and 4 seams.	Lackawanna township	do	128,800	17	Anthracite, free-burning	Do.
Mount Pleasant mine, E or Diamond, F or Rock, G or Big seams.	Scranton	William T. Smith	137,957	20	Anthracite	Del., Lacka., and Western R. R. Co.
Meadow Brook and National mine.	Scranton	William Connell & Co.	236,100	6	Anthracite	Del., Lacka. and Western R. R. Co.
Erie mine, Carbondale seam	Carbondale township	Hillside Coal and Iron Co.	73,767	7½	Anthracite, very light, free-burning; chequered or open-grained.	Buffalo and Honesdale, Pa., via D and H. C Co.'s R. R., N. Y., L. E. and W. R. R., D. and H. C. Co.'s R. R. and Gravity road.
Springbrook mine, B and D. seams.	Moosic	do	104,413	11	Anthracite, fracture partly conchoidal, partly open-grained.	Do.

a The product is that for the census year, July 1, 1869, to June 30, 1880.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LACKAWANNA CO.—continued.			*Feet.*		
Pierce mine, Archbald seam.	Archbald	Jones, Simpson & Co.	81,556	9½	Anthracite, white ash.	N. Y., via Del., Lacka. and West. R. R.
Jones, Simpson & Co.'s mine, Archbald seam.	do	do	64,960	8½	Anthracite, white ash, iron and steam.	Del. and Hudson Can. Co., via Gravity road.
Filer & Livey mine, Grassy Island and Archbald seam.	Winton	Geo. Filer and Thos. Livey.	107,078	16	Anthracite.	N. Y., via D., L. and W. R. R.
Jermyn No. 3 mine, Clark seams.	Green Ridge	John Jermyn	163,789	8	do	D. and H. C. Co., and D., L. and W. R. R.
Roaring Brook mine, Upper, Middle, and Lower seams.	Borough of Dunmore	Roaring Brook Coal Co.	132,023	12	do	N. Y., via D., L. and W. R. R. and Morris and Essex R. R.
School Fund mine, Rock and G seams.	Scranton	School Fund C. Asso'n, l'd.	77,952	18	do	Del. and Hudson Canal Co.
Brisbin mine, Big or G seam.	do	Del., Lack. and West. R. R. Co.	147,599	8–9	do	N. Y., Syracuse, Oswego, Buffalo, and Chicago, via D., L. and W. R. R.
Sloan mine, G or Big, F or Rock seams.	Lackawanna	do	147,663	9 6	do	Do.
Continental mine, G or Big, H or Clark seams.	do	do	148,738	8 5	do	Do.
Hampton mine, G or Diamond, F or Rock seams.	Lackawanna township	do	91,278	9½	do	Do.
Scranton Coal Company's mine, G and A seams.	do	do	None.	18	do	Do.
Cayuaga mine, G or Big seam.	Scranton	do	130,204	8	do	Do.
Archbald mine, Clark and Rock seams.	Lackawanna township	do	None.	11½	do	Do.
Bellevue mine, H or Clark, F or Rock seams.	Bellevue	do	215,809	13	do	Do.
Taylor mine, H or Clark seam.	Taylorville	do	176,129	7	do	Do.
Hyde Park mine, G or Big, F or Rock seams.	Scranton	do	19,149	15	do	Do.
Diamond mines, G or Big, F or Rock, E or Diamond seams.	do	do	399,807	20½	do	Do.
Oxford mine, E or Diamond, F or Rock seams.	Hyde Park	do	None.	12½	do	Do.
Pyne mine, Clark and I seams.	Lackawanna	do	206,678	17	do	Do.
Central mine, G or Big seam.	15th Ward, Scranton	do	180,371	11	do	Do.
Dodge mine, G or Big, F or Rock seams.	Scranton	do	67,332	16	do	Do.
Chestnut Hill mine	Carbondale	E. E. Hendrick	None.		do	Local.
Capuse mine, Clark seam.	Scranton	Lack., L and C. Co	195,918	7	do	Scranton and N. Y., via D., L. and W. R. R.
Pine Brook mine, Clark seam	do	do	109,910	6½	do	Co.'s I. and S. Works, Scranton, via D., L. and W. R. R.
Von Storch mine, Clark, 14-foot and Diamond seams.	Providence	Del. and Hud. Can. Co.	272,940	19	Anthracite, hard white ash.	Rondout, N. Y., and inland cities in North and West, via D. and H. C. Co.'s Can. and R. R., and N. Y., L. E., and W. R. R., and connections.
Powderly mine, top and bottom seams.	Carbondale	do	None.	7	do	Do.
Marvine mine, 14-foot seam.	Providence	do	215,097	7–9	do	Do.
Plymouth No. 4 mine, Red Ash seam.	Plymouth	do	106,690	16	Anthracite, hard red ash	Do.
Coal Brook mine, Carbondale seam.	Carbondale	do	220,586	7	Anthracite, hard white ash.	Do.
No. 1 shaft mine, Carbondale seam.	do	do	14,225	10	do	Do.
Grassy Island mine, Diamond and Grassy Island seams.	Olyphant	do	185,362	12	do	Do.
Olyphant No. 2, or Eddy Creek mine, No. 2 and Grassy Island seams.	do	do	138,926	8	do	Do.
No. 3 shaft, Carbondale seam.	Carbondale	do	6,844	4½	do	Do.
White Oak mine, Archbald seam.	Archbald	do	163,668	7	do	Do.
Legitt's Creek mine, Diamond and 14-foot seams.	Providence	do	180,237	13	do	Do.
Racket Brook Breaker mine.	Carbondale	do	177,798		do	Do.
Elk Hill Coal and Iron Company's mine, H. and R. seams.	Dickson city	Elk Hill C. and I. Co	38,770	5	Anthracite, white ash, free-burning.	D. and H. C., via D. and H. C. Co. to Rondout and N. Y.; North by E. R. R., and Albany and Susquehanna.
Elk Creek mine, No. 1 and bottom seams.	Fell township	Breman & Bridget	19,136	5½	do	
Fair Lawn mine, Clark seam.	Scranton	Fair Lawn C. Co., limited.	30,821	7	Anthracite, hard white ash, Cupelo furnace.	D., L., and W. Co., and Scranton.
Jermyn shaft	Jermyn	John Jermyn	126,460		Anthracite	
Jermyn Slope mine	do	do	5,491		do	
Green Ridge (3 collieries), Clark seam.	Scranton	Green Ridge C. Co	110,150	7	Anthracite, white ash, hard-burning.	Del. and Hud. Canal Co.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LACKAWANNA CO.—continued.			*Feet.*		
Penna. Coal Co.'s mine, top, midddle, and bottom seams.	Dunmore	Penna. Coal Co	151,895	13½	Anthracite, white ash, free-burning.	N. Y., via N. Y., L. E., and W. R. R. and Co.'s gravity road.
Clark mine, Clark and middle seams.	Carbondale	Watkins & Williams	7,332	12	do	Butler & Co., Pittston.
	LUZERNE COUNTY.					
Council Ridge mine, Buck Mountain seam.	Eckley	J. Leisenring & Co	209,481	12	Anthracite	Phila. and N. Y., via L. V. Cen. R. R.
Hollenback mine, Primrose and Holmes seams.	Plainsville	Robert S. Poole	16,800	13	Anthracite, pure primrose	N. Y. line of P. and N. Y. R. R. and N. Y. C. R. R., via Lehigh Valley R. R.
Franklin mine, Baltimore seam.	Wilkes-Barre	Franklin Coal Co	155,914	17	Anthracite, white ash	N. Y., via L. V. and Easton Amboy R. R.
Mount Pleasant mine, Mammoth and Wharton seams.	Hazleton	Pardee Sons & Co	83,349	5–40	Anthracite	L. Val., Pa.; tide-water at Perth Amboy, N. J., via L. V. R. R.
Pond Creek mine, Buck Mountain seam.	Pond Creek	Pond Creek Co	2,240	6	Anthracite, hard, pure, free-burning.	N. Y., via L. and Sus. R. R. and Cen. R. R. of N. J.
Hollywood mine, Monmouth and Wharton seams.	Hazleton	Calvin, Pardee & Co	92,211	32–40	Anthracite	L. V. R. R. Tide-water at Perth Amboy, N. J., via L. V. R. R.
Susquehanna mine, B., C., E., G., and H. seams.	East and West Nanticoke.	Susquehanna, C. Co	733,622	40	Anthracite and white ash	Havre de Grace to Charleston, S. Amboy to Maine, Baltimore, Columbia, on Pa., R. R.; Deleware City to Maine, Ohio wharf on Pa. R. R. to Saint Louis and Chicago.
Ramboille or Mill mine, Ross and —— seams.				9		N. Y., via D. L. and W. R. R.
Hollow mine, Red Ash seam.	Mill Hollow	Waddell & Walter	40,320	12	Anthracite	Morris and Essex R. R.
Columbia mine, Pittston and Chequered seams.	Marcy township	Grove Bro's	20,729	10½	do	D. L. and W. R. R. and L. and B. to Danville.
Hillman's mine, Hillman seam.	Wilkes-Barre	H. Baker Hillman	44,800	8½	Anthracite, white ash, free-burning.	N. Y. and Buffalo, via L. V. R. R., P. and N. Y. R. R., Belvidere and Del. R. R.
Lattimer mine, bottom 2-foot and 7-foot seams; Poorman, top, and 6-foot seams.	Lattimer	Pardee Bro. & Co	252,228	31	do	N. Y. and Phila., via L. V. R. R.
Beaver Brook mine, Mammoth and Wharton seams.	Beaver Brook	C. M. Dodson & Co	78,964	27	Anthracite, white ash, hard-burning.	N. Y. and Bethlehem and places between mine and N. Y. and Phila., via L. V. R. R., N. J. C. R. R. and L. Canal.
Ebervale mine, Mammoth seam.	Ebervale	Ebervale Coal Co	218,562	20–22	Anthracite	N.Y., via L. V. R. R.
Butler mine	Pittston	Butler Colliery Co	53,760	6	Anthracite, hard, free-burning.	Elmira, Rochester, Buffalo, Toronto, Chicago, and Milwaukee, via D. and H. C. R. R., Erie R. R., L. E. G't W. and G'd Trunk of Canada.
Upper Lehigh mine, Buck Mountain seam.	Upper Lehigh	Upper Lehigh C. Co	374,115	11	Anthracite	N. Y. and Phila. and intervening points, via C. R. R. of N. J., N. P. R. R., and Bel. and Del. R. R.
East Boston mine, Cooper and Bennett seams.	Kingston	W. G. Payne & Co	116,614	17	do	N. Y., via D., L. and W. R. R.
Stout mine, Mammoth seam	Milnesville	Stout Coal Co	91,612	20–22	do	N. Y., via L. V. R. R.
Maltby mine, Maltby seam	Kingston township	Caleb S. Maltby	77,037	5	Anthracite, white ash	N. Y., via D., L. and W. R. R.
East Sugar Loaf mine, Mammoth and Wharton seams.	Stockton	Linderman Skeer & Co.	265,736	36	do	N. Y. and Phila., via L. V. R. R.
Humboldt mine, Wharton seam.	Humboldt	do	75,779	8	Anthracite, white ash, free-burning.	Do.
Sandy Run mine, Buck Mountain seam.	Sandy Run	M. S. Kemmerer & Co.	115,709	18	Anthracite	N. Y. and Phila. and intervening points, via L. and Sus. Div. N. J. C. R. R. and N. Y. and N. Pa. branch of P. and R. and by Canal.
Gaylord mine, Cooper, Bennett, and Ross seams.	Plymouth	Gaylord Coal Co	19,299	24	Anthracite, white ash, free-burning.	N. Y., Harrisburgh, and Balt., via D. L. and W. R. R., and North. Cen. R. R.
Hillside mine, A and B seams.	Pleasant Valley	Hillside C. and I. Co	106,404	10	Anthracite, fracture partly conchoidal, partly open-grained, steam and domestic.	Buffalo, Honesdale, for Erie R. R., via L. V. R. R., N. Y., L. E and W. R. R., D. and H. Co.'s R. R., N. Y., and L. E. and W. R. R., D. and H. Co.'s R. R., and Gravity road.
Avondale mine, Red Ash or Big seam.	Plymouth	Del., Lack. and West. R. R. Co.	175,065	17	Anthracite	N. Y., Syracuse, Oswego, Buffalo, and Chicago, via D. L. and W. R. R.
Boston mine, Boston and Lance seams.	do	do	143,979	5½–12	do	Do.
Everhart mine, Bottom seam.	Jenkins township	Waddell & Co	53,441	7	Anthracite red ash, free-burning, domestic, and furnace.	N. Y., via N. J. C. R. R.
Buck Mountain Coal Company mine, Buck Mountain seam.	Buck mountain	Buck Mountain Coal Co.	149,555	15–16	Anthracite, pink sandy ash, superior for steam.	Pa. and N. J., via L. V. R. R. and connections.
Plymouth No. 2 mine, H or Hillman, and F and E or Cooper seams.	Plymouth	Del. and Hud. Can. Co	108,697	18½	Anthracite, hard white ash	Rondout and N. Y., and inland cities north and west, via D. and H. C. Co.'s Canal and R. R. and N. Y., L. E. and W. R. R.
Pine Ridge mine, E and Baltimore seams.	Plains	do	93,736	15	do	Do.
Baltimore Slope mine, Baltimore seam.	Parsons	do	138,451	15	do	Do.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LUZERNE CO.—cont'd.			*Feet.*		
Plymouth No. 3 mine, Cooper and Bennett seams.	Plymouth	Del. and Hud. Can. Co.	21,460	7	Anthracite, hard white ash	Rondout and N. Y., and inland cities north and west, via D. and H. C. Co.'s Canal and R. R. and N. Y., L. E. and W. R. R.
Laurel Run mine, E or Baltimore seam.	Parsons	do	168,317	13½	do	Do.
Mill Creek mine, E or Baltimore seam.	Plains	do	212,081	15	do	Do.
Plymouth No. 5 mine, E or Baltimore seam.	Plymouth	do	179,894	15	do	Do.
Baltimore Tunnel mine, E or Baltimore seam.	Wilkes-Barre	do	195,779	15	do	Do.
Conyngham Shaft, E or Baltimore seam.	do	do	None.	15	Anthracite	Rondout, N. Y.
Hazleton No 6 mine, Mammoth seam.	Hazleton	A. Pardee & Co	23,852	18	Anthracite, free-burning, white ash.	Fices on L. river, tide-water and points on L. Valley and connecting roads, via L. V. R. R.
Sugar Loaf mine, Mammoth and Wharton seams.	do	do	59,121	21	do	Do.
Hazleton No. 3 mine, Mammoth seam.	do	do	None.	18	do	Do.
East Crystal Ridge mine, Mammoth seam.	do	do	47,116	18	do	Do.
Cranberry mine, Mammoth and Wharton seams.	do	do	62,146	21	do	Do.
Hazleton mine, Mammoth seam.	do	do	86,128	20	do	Do.
Laurel Hill mine, Mammoth seam.	do	do	167,061	20	do	Do.
South Sugar-Loaf mine, Mammoth and Wharton seams.	do	do	17,063	24	do	Do.
Kingston Collieries, Bennett & Cooper seam.	Kingston	Kingston C. Co., lim	462,391	17½	Anthracite	D., L. and W. R. R. and Messrs. Cunningham & Co., via D., L. and W. R. R. and N. C. R. R., and P. and E. R. R. and vessels.
Wyoming mine, Baltimore seam.	Plains	J. H. Swoyer	225,120	9–14	do	N. Y. and the west.
Sugar Notch No. 10 mine, Kidney seam.	Sugar Notch	Lehigh and Wilkes-Barre C. Co.	90,733	6	do	N. Y. and eastern markets and Cen. R. R. of N. J. and Lehigh canal.
Hollenback No. 2 mine, Baltimore seam.	Wilkes-Barre	do	25,949	16	do	Do.
Wanamie No. 18 mine, Baltimore and Ross seams.	Wanamie	do	185,662	13	do	Do.
Stanton No. 7 mine, Baltimore seam.	Wilkes-Barre	do	74,677	16	do	Do.
Reynolds No. 16 or Washington mine, Red-Ash seam.	Plymouth	do	207,179	15	do	Do.
Lance No. 11 mine, Cooper seam.	do	do	124,772	6	do	Do.
Empire No. 4 mine, Baltimore and Hillman seams.	Wilkes-Barre	do	358,457	21	do	Do.
Sugar Notch No. 9 mine, Ross and Red-Ash seams.	Sugar Notch	do	112,423	17	do	Do.
Diamond No. 1 mine, Baltimore seam.	Wilkes-Barre	do	174,059	14	do	Do.
Nottingham No. 15 mine, Red-Ash seam.	Plymouth	do	394,269	15	do	Do.
Hartford No. 6 mine, Red-Ash, Ross, and Baltimore seams.	Ashley	do	208,504	27	do	Do.
Harleigh mine, Mammoth and Wharton seams.	Harleigh	McNair & Co	45,094	33	Anthracite, furnace, and domestic.	Phila. and tide ports near N. Y. and intervening points, via L. V. R. R. and connections.
Oak Dale mines, Nos. 1 and 2.						
Highland mines, Nos. 1 and 2, Mammoth, Highland, and Buck Mountain seams.	Jeddo	G. B. Markle & Co	430,080	29–50	Anthracite, white and pink ash, steam.	N. Y. and Phila. and markets beyond tide-water, via L. V. R. R. and connections.
Cross Creek Collieries, Buck Mountain seam.	Drifton	Coxe Bros. & Co	415,958	11	Anthracite, red ash	Lehigh Val., N. Y., tide-water and the west, via Lehigh Val. and C. R. R. of N. J.
Phœnix mine, second and third seams.	Pittston township	Phœnix Coal Co	42,290	16	Anthracite, white ash	N. Y., via D., L. and W. R. R.
Kingston Black Diamond mine, Bennett seam.	Kingston	T. C. Hutchison	125,113	6	Anthracite, white ash, free-burning.	
Salem mine, third seam	Shickshinny	Salem Coal Co	44,800	3	Anthracite, fawn ash	South and west and interior within radius of 100 miles, via Pa. can. and R. R., and D., L. and W. R. R.
Enterprise mine, upper and lower seams.	Plainsville	H. C. Roberts & Co	120,240	14	Anthracite	N. Y., Rochester, Buffalo, and Chicago, via D., L. and W. R. R., and N. Y. Cen. R. R.
Forty Fort mine, Cooper & Bennett seam.	Forty Fort	J. H. Swoyer	100,270	11½	Anthracite, white ash, free-burning.	

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LUZERNE CO.—cont'd.			*Feet.*		
Tompkins mine, 7-foot seam	Pittston	A. Tompkins	9,554	4½	Anthracite, white ash, free-burning.	Elmira, Auburn, Buffalo, N. Y. and N. Y. city, via Pa. and N. Y. R. R., L. V., South. Cen., N. Y., L. E. and W., and N. Y. C. and H. R. R. R.
Warrior Run mine, B, C, D, and E seams.	Sugar Notch	A. J. Davis	56,000	31½	do	
Seneca mine, Pittston and third seams.	Pittston	Pittston Coal Co	66,838	9½	Anthracite, hard and medium.	Buffalo, Fair Haven, Watkins on Seneca lake, N. Y. and line trade, via L. V. or P. and N. Y. R. R. and over the Erie.
Twin mine, third seam	do	do	8,277	3½	do	Buffalo, N. Y., Fair Haven, Watkins, N. Y., via L. V. or P., N. Y. C. R. R., N. Y., L. E. and W. R. R.
Chauncy mine, Ross and lower seams.	Avondale	T. P. McFarlane	33,600	6, 20	Anthracite, red and white ash, free burning.	
Penna. Coal Co. (7 collieries), upper, 14-foot, 7-foot, and lower seams.	Pittston	Penna. Coal Co	1,221,426	26	Anthracite, white ash, free-burning.	N. Y., via N. Y., L. E. and W. R. R. Co.'s gravity road.
Dodson mine, Lance, Cooper, and Hillman seams.	Plymouth	Plymouth Coal Co	54,392	21	Anthracite	N. Y., via D., L. and W. R. R. and its divisions.
Exeter mine, Pittston seam	Exeter township	Lehigh Valley Coal Co	240,890	14	do	All over the country, via L. V. R. R. and its connections.
Mineral Spring mine, Baltimore seam.	Parsons borough	do	89,600	14	do	U. S. and Canada, via L. V. R. R. and its connections.
Prospect mine, Baltimore seam.	Plains township	do	229,600	8–12	do	From Atlantic coast to Rocky mountains, via L. V. R. R. and connections.
Midvale mine, Hillman, Bowkley, and Abbott seams.	do	do	48,160	22	do	Atlantic seaboard to Great Lakes and Saint Lawrence, via L. V. R. R. and connections.
Henry mine, Baltimore seam	do	do	109,760	14	do	Any point reached on Great Lakes and Saint Lawrence river, via L. V. R. R. and connections.
Spring Mountain mine	Jeansville	J. C. Haydon & Co	203,392		do	N. Y. and Phila. and east and south, via L. V. R. R. and L. V. and North Pa. R. R.
	NORTHUMBERLAND COUNTY.					
Peerless mine, Red-Ash, Pink-Ash, and Diamond seams.	Shamokin	Crinkshank & Emes	28,000	5	Anthracite, red ash, free-burning.	Phila., Balt., and Washington.
Greenback mine, No. 8, No. 9, and Buck Mountain seams.	do	H. J. Londy	26,569	18	Anthracite, white and pink ash.	Phila. and Port Richmond, via P. and R. R. R.
Enterprise mine, Nos. 8 and 9 seams.	Excelsior	Enterprise Coal Co	91,277	15	Anthracite, white ash, free-burning.	Phila, Boston, and south, via P. R. R. and canal.
Locust Gap mine, Mammoth seam.	Locust Gap	Graeber & Shepp	95,200	22	Anthracite, hard, white ash, free-burning.	Phila., N. Y., Erie, Balt., and Washington, via P. and R. and Schuylkill can. and Northern Cen. and Pa. R. R.
Royal Oak mine, Pink Ash seam.	Shamokin	Tillett & Bro	560	5	Anthracite, pink ash	Own town.
	Mount Carmel		None.		Anthracite	
Henry Clay No. 1 mine, Nos. 8 and 9 seams.	Shamokin	J. Langdon	140,325	6	do	Chicago, via North. Cen., N. Y. Cen., and H. R. R. R. and lakes.
Ben Franklin mine, Lykens Valley seam.	Dontyville	Donty & Baumgardner	50,509	7–11	Anthracite, red ash	Phila., N. Y., and Boston, via P. and R. R. R., and Schuylkill canal.
Cameron mine, Nos. 2, 8, 9, and 10 seams.	Shamokin	Mineral R. R. and Mining Co.	170,901	28	Anthracite, free-burning	Phila., Balt., and W. Erie, Buffalo, and Elmira, via North. Cen. R. R., Phila., and Erie to West and South and Penn. R. R.
Luke Fiddler mine, Nos. 8 and 9 seams.	do	do	132,614	13	Anthracite, white ash, free-burning.	Phila., Balt., Erie, and Buffalo, via North. Cen. R. R., Pa. R. R., and Phila. and Erie R. R.
Pennsylvania mine, Nos. 8 and 9 seams.	Mount Carmel	do	47,604	14	Anthracite, white ash	Do.
Hickory Ridge mine, Nos. 7, 8, and 9 seams.	Shamokin	do	None.	16	Anthracite	
Hickory Swamp mine, Nos. 8 and 9 seams.	do	do	None.	11	Anthracite, free-burning	
Monitor mine, Mammoth seam.	Locust Gap	Geo. W. Johns & Bro	122,107	22	Anthracite, white ash	Phila., via, Mahanoy and Shamokin Br. Mine Hill, Scuyl. Haven Br., and P. and R. R. R., and North. Cen. and Pa. R. R.
Black Diamond mine, upper and lower seams.	Mount Carmel	Wm. Schwenk & Co	33,937	5, 5½	Anthracite, white ash, free-burning.	
Lancaster mine, Nos. 8 and 9 seams.	Coal Run	Smith, Keiser & Co	15,636	10½	do	
Buck Ridge mine	Coal township	May Audenried & Co	84,000	14	Anthracite, white ash	Richmond, Phila., Erie, and Elmira, via P. and R. R. R., and North. Cen. R. R.
Excelsior Coal-Mining Co.'s mine, Nos. 8 and 9 seams.	do	Excelsior C. Min. Co	83,053	14	Anthracite, white ash, free-burning.	W. Buffalo, Erie, E. Phila., and New England, via E. Phila. and Read. R. R. and W. North. Cen. R. R.
Mount Carmel mine, Mammoth and Skidmore seams.	Mount Carmel	Montelins, Robinson & Co.	47,782	30	do	N. Y., Phila., Balt., Buffalo, Erie, and the west, via L. V. R. R., P. and R. R. R. and North. Cen. and Pa. R. R.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	NORTHUMBERLAND CO.—continued.			*Feet.*		
Big Mountain mine, Nos. 8 and 9 seams.	Near Shamokin	Patterson, Llewellyn & Co.	155,951	11	Anthracite, medium hard, white ash, some red and pink ash, domestic and lime and brick burning.	Phila., N. Y., Boston, Lewiston, Erie, Buffalo, and Balt., via P. and R. R. R. and North. Cen. R. R., P. and E. R. R., and N. Cen., and P. R. R.
Sterling mine, Twin seam	Shamokin	Kendrick & Co	77,684	15	Anthracite, white ash, free-burning.	Phila., Elmira, Buffalo, and Erie, via P. and R. R. R., and North. Cen. R. R.
Carson mine, Diamond seam	do	Philip Goodwill	7,458	6½	Anthracite, gray ash, free-burning.	
Mount Carmel shaft; Nos. 8 and 9 seams.	Mount Carmel township.	Phila. and Reading C. and I. Co.	204,848	17	Anthracite, white ash, free-burning.	P. and R. R. R., Schuyl. Can., Sus. Can. to the lakes, Phila. and Erie R. R.
Merriam mine, Mammoth and Skidmore seams.	Coal township	do	73,584	28	do	Do.
Burnside mine, Nos. 8 and 9 seams.	do	do	57,792	17	do	Do.
Geo. Fales mine, No. 12 seam	do	do	1,904	6	do	Do.
N. Franklin No. 2 mine, Nos. 8 and 9 seams.	Trevorton	do	88,144	17	do	Do.
Bear Valley mine, Nos. 8 and 9 seams.	Coal township	do	111,104	17	do	Do.
N. Franklin No. 1 mine, Upper Lykens Valley seam.	Zerbe township	do	None.	9	do	Do.
Helfenstein mine, Upper Lykens Valley seam.	Cameron township	do	None.	9	do	Do.
Henry Clay mine, Nos. 8 and 9 seams.	Coal township	do	None.	17	do	Do.
Locust Spring mine, Mammoth seam.	Mount Carmel township.	do	65,968	22	do	Do.
Reliance mine, Nos. 8 and 9 seams.	do	do	85,456	17	do	Do.
	SCHUYLKILL COUNTY.					
East Lehigh mine, Buck Mountain seam.	Tamaqua	Mitchel & Symons	4,403	7	Anthracite, hard, free-burning, pink ash, domestic use.	Phila. and along line of P. and R. R. R.
Cambridge mine, Primrose seam.	Shenandoah	Cambridge Coal Co	3,068	8	Anthracite, soft, free-burning.	Phila., via P. and R. R. R.
Stanton mine, Mammoth seam.	Mahanoy Plane	Miller, Hoch & Co	94,158	27½	Anthracite, hard, white ash	Do.
Bear Ridge No. 1 mine, Mammoth seam.	do	Myers, McCreary & Co	87,288	32½	Anthracite	Line of P. and R. R. R., Phila., N. Y., and Boston, to Phila., via P. and R. R. R. and Schuyl. Canal.
Bear Ridge No. 2 mine, Mammoth seam.	do	do	57,472	25	do	Do.
Palmer Vein mine, Palmer, Charley Pott, Clarkson, and Peach Mountain seams.	New Philadelphia	Alliance Coal Mining Co.	20,738	14	Anthracite, red ash	Via P. and R. R. R. to Phila., and via Schuyl. Canal to N. Y.
C Vein mine, C seam	Tamaqua	August Raabe	1,322	9	Anthracite	Tamaqua.
Kehley's Run mine, Mammoth, 7-foot, and Buck Mountain seams.	Shenandoah city	Thomas Coal Co	166,530	65½	Anthracite, hard, white ash	Via P. and R. R. R. to Phila., Del. and Raritan Canal, and vessels to N. Y. and Boston.
Sharp Mountain mine, Bancroft seam.	Pottsville	Thomas Wren	4,025	6–8	Anthracite, red ash	Pottsville and vicinity by wagon.
Peach Orchard mine, Little Tracy seam.	Howegen	T. Heilman	134	2	do	Richmond, by P. and R. R. R.
William Penn mine, Mammoth seam.	William Penn	William Penn Coal Co.	179,200	40	Anthracite	Phila. and along P. and R. R. R.
Web-ter mine, Buck Mountain seam.	Mahanoy City	Layton S. Baldwin	2,570	10	do	Phila. and along P. R. R. R. and branches.
New Boston mine, B, D, and E seams.	do	Joseph F. Hitch	25,749	33	do	N. Y., via L. V. R. R.
Cuyler mine, Mammoth and Buck Mountain seams.	Raven Run	S. M. Heaton & Co	139,953	35	Anthracite, hard, white ash.	Phila. and N. Y., via P. and R. R. R., and places on Atlantic coast.
Lincoln mine, Lykens Valley seam.	Tremont township	Levi Miller & Co	126,323	6	Anthracite, red ash	N. Y. and Eastern states, via P. and R. R. R. and vessels.
Draper mine, Mammoth and Primrose seams.	Gilberton	Oliver Ditson	103,277	53	Anthracite, hard, white ash.	Phila., via P. and R. R. R.
Rausch Creek mine, Mammoth seam.	Rausch Creek	Miller, Graeff & Co	109,760	12	Anthracite, gray ash, free-burning.	Harrisburg, Reading, Phila., N. Y. and Boston, via P. and R. R. R. and canal.
Big Spring mine, Speedmore seam.	New Castle	T. E. Ferrebee & Co	67	2–3	Anthracite, hard, white ash	Schuyl. Haven, Reading, Palo Alto, and Lancaster, via P. and R. R. R.
Mammoth mine	do	Quinn & Mahony	634	20	Anthracite, white ash	Dauphin county and Port Richmond, via P. and R. R. R.
Ellsworth mine, Mammoth and Leeler seams.	Broad Mountain	John R. Davis	14,603	70	Anthracite, white ash, free-burning.	Phila. and line of road, Reading and Pottstown, via P. and R. R. R.
Peach Orchard, Orchard 1 and 2 seams.	Wadesville	Morgan & Brown	1,792	3	Anthracite, red ash, free-burning.	Pottsville, via P. and R. R. R.
Primrose mine, Mammoth, Primrose, and Skidmore seams.	Mahanoy City	Caleb B. Knevals	47,488	33	Anthracite, hard, pink ash	N. Y. City and vicinity, via L. V. and Eastern and Amboy R. R.
Middleport mine, Little Diamond seam.	Middleport	Lewis Lorenze	1,120	3	Anthracite, red ash	Port Richmond and Phila., via P. and R. R. R.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SCHUYLKILL CO.—continued.			*Feet.*		
Glendon mine, Skidmore, 7-foot, and Buck Mountain seams.	Mahanoy	J. C. Hayden & Co	59,531	28	Anthracite, hard, white ash, long fracture.	N. Y., via L. V. R. R. and vessels; Phila., via L. V. R. R. and North Pa. R. R.
Laurel Ridge mine, Mammoth seam.	Gilberton	John A. Dutter	17,504	30	Anthracite, hard, white ash	Phila., via Mahanoy Plane and P. and R. R. R.
Kohinoor mine, Mammoth seam.	Shenandoah	Richard Heckscher	170,583	15–40	do	Phila., via P. and R. R. R.
Crystal mine, Mammoth seam	New Castle	Joseph Brady	1,344	125	Anthracite	Phila, and line of P. and R. R. R.
Rausch Gap mine, Skidmore seam.	Hegins township	W. H. Yohe	383	7	Anthracite, hard	To farmers and others through Lykens and Pine valleys by wagon.
Eureka mine, Mammoth seam.	Gilberton	Edward Garman & Co.	4,032	25	Anthracite, white ash	Phila, via Schuylkill Haven.
Kalmia mine, Lykens Valley seam.	Kalmia	Phillips & Shaefer	85,882	12½	Anthracite	Boston and vic., N. Y. and vic., Phila. and vic., via P. & R. R. R. and vessels.
West Lehigh mine, Buck Mountain, Skidmore, Bottom, and Mammoth seams.	Shoemaker's	Fisher Hazard	34,739	41	do	Perth Amboy, N. J., via L. V. R. R.
Staffordshire mine, Diamond seam.	Mahanoy City	Jones, Ward & Co	16,504	7	Anthracite, pink ash	Phila., via P. and R. R. R.
Saint Clair mine, Holmes seam.	Saint Clair	Atkinson & Lessig	2,800	4	Anthracite, red ash	Do.
Big Mine Run mine, Buck Mountain seam.	Near Ashland	Jere. Taylor & Co	98,405	17	Anthracite, white ash	Do.
Monitor mine, Holmes seam.	Wadesville	John Denning	2,240	5	Anthracite	Phila., and line of P. and R. R. R.
Eagle mine, 7-foot, Mammoth, and Skidmore seams.	Saint Clair	Geo. W. Johns & Bro.	50,279	40	Anthracite, hard, white ash.	Phila., via Mill Creek Br., Schuyl. Valley Br., and P. and R. R. R.
No. 8 mine, Mammoth seam	Coaldale	Lehigh Coal and Nav. Co.	122,170	60	Anthracite	N. Y. and Phila., via Cen. R. R. of N. J., and L. C. and Nav. Co.'s canal.
No. 10 mine, Mammoth seam.		do	120,326	50	do	Do.
No. 11 mine, Primrose, Mammoth, and Skidmore seams.	Gearytown	do	83,599	64	do	Do.
Honey Brook Nos. 1, 4, and 5 mines, Mammoth, and Wharton seams.	Audenried	Lehigh and Wilkes-Barre C. Co.	296,295	28	Anthracite, hard, white ash.	N. Y., Phila., line of L. Val., furnace, and C. R. R. of N. J., via C. R. R. of N. J. and L. and Del. divn. canals
North Star mine, Skidmore and 7-foot seams.	Mahanoy City	Reynolds, Roberts & Co.	22,400	4	do	Phila., via P. and R. R. R.
Shenandoah No. 2 mine, Mammoth seam.	Lost Creek	Phila. Coal Co	153,707	40	Anthracite, white ash	N. Y. and Phila., and points between, via L. V. R. R. and P. and R. R. R.
Colorado No. 1 mine, Mammoth seam.	Colorado	do	106,6 5	30–40	do	Do.
Lehigh No. 3 mine, Mammoth seam.	Near Shenandoah	do	110,240	40	do	Do.
Packer No. 4 mine, Mammoth, Holmes, and Primose seams.	Lost Creek	do	251,070	53	do	Do.
Lawrence mine, Mammoth seam.	Mahanoy Plain	Lawrence Merkel & Co	102,461	40	Anthracite, hard, white ash	Phila., via P. and R. R. R.
Indian Run mine, Buck Mountain and Skidmore seams.	Near Mahanoy City	Parmley & Russell	None.	16	Anthracite	
Altamont No. 2 mine, Mammoth, 7-foot Skidmore, and Red Ash seams.	Frackville	Broad Mt. Land	500	51	Anthracite, white ash, with red, pink, and gray ash.	Phila and N. Y., via P. and R. R. R. and L. V. R. R.
Pinedale mine	Middleport	Rothermel & Lorenz	None.		Anthracite, red ash	
Pioneer mine, Mammoth seam.	Ashland	D. Vaughan & Co	2,520	6	Anthracite, white ash, free-burning.	
West Lehigh mine, Mammoth seam.	Tamaqua	Wood & Pierce	15,904	30	do	
York Farm mine, Tunnel seam.	Yorkville borough	Job Rich	840	4¾	Anthracite, red ash	Local trade.
Coal Run mine, Primrose and Diamond seams.	Saint Nicholas	Suffolk Coal Co	96,723	24	Anthracite	Phila., line of P. and R. R. R. and branches, Mass., and Maine.
Franklin mine, Lykens Valley seam.	Barry township	S. S. Bickel	30,200	8	Anthracite, red ash, free burning.	
Wolf Creek mine, Big Diamond seam. / Big Diamond mine, Big Orchard seam.	Near Minersville	James F. Donahue	4,480	6 / 3	do	Richmond and Phila. and intermediate points.
Hillside mine, Skidmore and 7-foot seams.	Mahanoy City	Harris, Spaar & Co	5,500	4–5	Anthracite, white ash, bright and hard.	Phila., via P. and R. R. R.
Black Heath mine, Skidmore, Bach, Black Heath, Leader, and Red Ash seams.	South Cass township.	W. H. Harris	26,246	20	Anthracite, white ash, free-burning.	
	Llewellyn	Dan. Hock	224		Anthracite	
		R. Holahan & Bro	5,824		do	
		S. Kestenbach and 30 other small concerns.				
Palmer, No. 1 seam	New Philadelphia	John Warren	305		do	
Oakdale mine, Holmes seam.	Shenandoah	E. L. Powell	426	9	Anthracite, white ash, free-burning.	Phila.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SCHUYLKILL COUNTY—continued.			*Feet.*		
Wolf Creek Diamond mine, Little and Big Diamond and Little and Big Orchard seams.	Minersville	John W. Davis	20,170	16	Anthracite, red ash, free-burning.	
West Brookside mine, Upper Lykens Valley seam.	Porter township	Philadelphia and Reading C. and I Co.	450,464	9	Anthracite, white ash, free-burning.	P. and R. R. R., Schuyl. and Sus. canals.
Tunnel mine, Mammoth seam.	Ashland	do	85,344	22	Anthracite, hard, white ash	P. and R. R. R., Schuyl. and Sus. canals to the lakes, and Phila. R. R.
Locust Run mine, Mammoth seam.	do	do	None.	22	do	Do.
East mine, Mammoth and Buck Mountain seams.	Butler township	do	156,128	34	do	Do.
North Ashland mine, Mammoth seam.	do	do	140,784	22	do	Do.
Preston mines, No. 1 and 2, Primrose, Mammoth, Holmes, and Buck Mountain seams.	do	do	102,033	46	do	Do.
Preston mine No. 3, Mammoth seam.	do	do	97,888	22	do	Do.
Conner mine, Buck Mountain seam.	do	do	147,840	12	do	Do.
Hammond mine, Mammoth seam.	do	do	130,928	34	do	Do.
Girard mine, Mammoth seam.	Girardville	do	111,104	22	do	Do.
Girard Mammoth mine, Buck Mountain seam.	Butler township	do	None.	16	do	Do.
Indian Ridge mine, Mammoth seam	Shenandoah city	do	190,960	30	do	Do.
Plank Ridge mine, 7-foot and Buck Mountain seams.	do	do	135,296	19	do	Do.
Pine Forest mine, Skidmore, Mammoth, and 7-foot seams.	East Norwegian township.	do	87,040	30	Anthracite, white ash, free-burning.	P. and R. R. R. Schuyl, and Sus. canals.
Rainbow mine, Mammoth and 7-foot seams.	Saint Clair	do	None.	29	do	Do.
Wadesville shaft, Mammoth and 7-foot seams.	Wadesvile	do	122,080	29	do	Do.
Beechwood mine, Mammoth and 7-foot seams.	Mount Laffee	do	81,596	29	do	Do.
Pottsville mine, Primrose and Diamond seams.	Norwegian township	do	27,216	17	do	P. and R. R. R., Schuyl. and Sus canals, and P. and E. R. R. to the lakes.
Pine Knot mine	Cass township	do	None.		do	P. and R. R. R., Schuyl. and Sus. canals.
Anchor mine	do	do	None.		do	Do.
Taylorsville mine	Foster township	do	None.		do	Do.
Mine Hill Gap mine, Mammoth seam.	Cass township	do	67,648	22	do	Do.
Thomaston mine, Mammoth and Skidmore seams.	Foster township	do	138,656	27	do	Do.
Phœnix Park No. 3 mine, Diamond seam.	Cass township	do	18,704	4	Anthracite, red ash, free-burning.	Do.
Richardson mine, Mammoth and Skidmore seams.	Foster township	do	121,296	27	Anthracite, white ash, free-burning.	Do.
Glendower mine, Mammoth seam.	do	do	58,240	22	do	Do.
Forestville mine, Skidmore seam.	Cass township	do	None.	6	do	Do.
Phœnix Park No. 2 mine, Primrose seam.	do	do	13,440	13	Anthracite, red ash, free-burning.	Do.
Shenandoah City mine, Mammoth seam.	Shenandoah city	do	76,608	30	Anthracite, hard, white ash.	P. and R. R. R., Schuyl. and Sus. canals to the lakes., P. and E. R. R.
Knickerbocker mine, Mammoth seam.	Mahanoy township	do	194,544	30	do	Do.
Ellangowan mine, Mammoth and Holmes seams.	do	do	7,392	42	do	Do.
West Shenandoah mine, Mammoth, 7-foot, and Buck Mountain seams.	Shenandoah city	do	132,160	41	do	Do.
Turkey Run mine, Mammoth seam.	do	do	100,016	40	do	Do.
Gilberton mine, Buck Mountain seam.	Gilberton	do	62,648	7	do	Do.
Furnace mine, Buck Mountain seam.	do	do	34,160	12	do	P. and R. R. R., Schuyl. and Sus. canals.
Bear Run mine, Mammoth seam.	Mahanoy township	do	64,288	22	do	P. and R. R. R., Schuyl. and Sus. canals to the lakes, P. and E. R. R.
Elmwood mine, Skidmore, 7-foot, and Buck Mountain seams.	Mahanoy City	do	91,504	25	do	Do.
Boston Run mine, Mammoth seam.	Mahanoy township	do	75,936	30	do	Do.

Directory of anthracite coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SCHUYLKILL COUNTY—continued.			*Feet.*		
Mahanoy City mine, Mammoth and Holmes seams.	Mahanoy City	Philadelphia and Reading C. and I. Co.	140, 560	32	Anthracite, hard, white ash.	P. and R. R. R., Schuyl. and Sus. canals to the lakes, P. and E. R. R.
North Mahanoy mine, Buck Mountain, 7 foot, and Skidmore seams.	do	do	126, 896	24	do	Do.
Schuylkill mine, Buck Mountain seam.	Mahanoy township	do	59, 248	16	do	Do.
Newkirk mine	Schuylkill	do	None.		do	P. and R. R. R., Schuyl. and Sus. canals.
Buckville mine	do	do	None.		do	Do.
Eagle Hill shaft, Mammoth and 7-foot seams.	Blithe township	do	116, 256	29	Anthracite, white ash, free-burning.	Do.
Swatara (late Pyne) mine, Mammoth and Skidmore seams.	Reilly township	do	27, 552	17	do	Do.
Otto mine, Mammoth, Black Heath, and Primrose seams.	do	do	73, 136	21	do	Do.
Middle Creek shaft	Fraley township	do	None.		do	Do.
East Franklin mine, Mammoth seam.	do	do	35, 392	22	do	Do.
Colket mine, Primrose, Holmes, Mammoth, and Skidmore seams.	Donaldson	do	49, 728	42	do	Do.
St. Nicholas mine	West Mahanoy	do	81, 003		Anthracite	
Coplay mine, Buck Mountain seam.	Mahanoy township	La Fayette Lentz	47, 357	16	do	N. Y., via L. V. R. R.
	SUSQUEHANNA COUNTY.					
Forest City mine, Forest City seam.	Clifford township	Hillside C. and I. Co.	18, 173	5½	Anthracite, very light, free-burning, open-grained.	N. Y., L. E. and W. R. R.

RHODE ISLAND.

	NEWPORT COUNTY.					
Mount Hope mine	Coal Mine station	Crocker Bros	6, 176	4–5	Plumbaginous anthracite	Taunton, Mass., and neighborhood.
Old shaft	do	do	None.	4	do	

VIRGINIA.

	PULASKI COUNTY.					
Altoona mine	Altamaha	Altoona C. and I. Co.	2, 600	25	Anthracite, white ash, free-burning.	Saltville, Va., Martin's Sta., depots at M. and O. Knoxville, Tenn., intermediate points, Fairville and int. points.

Directory of semi-anthracite coal mines.

PENNSYLVANIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SULLIVAN COUNTY.			*Feet.*		
State Line and Sullivan R. R. Company's mine.	Bernice	State Line and Sullivan R. R. Co.	70, 560	8	Hard, semi-bituminous, or free-burning anthracite.	N. Y. state and west of Buffalo.

Directory of bituminous coal mines.

ALABAMA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind and use when reported.	Markets and routes.
	DE KALB COUNTY.			*Feet.*		
.....	.....	Campbell & Co	3,000	3	Bituminous	Chattanooga, Tenn., by rail.
	JACKSON COUNTY.					
.....	.....	Belmont C. and R. R. Co.	25,000	.....	do	Memphis, Charleston, R. R. locomotives, Huntsville, Tuscumbia, Florence, and other towns on M. O. C. R. R. in Alabama and Memphis, Tenn.
	JEFFERSON COUNTY.					
Jefferson mine, Jefferson and Black Creek seams.	Jefferson	J. G. Massie	28,000	2½ 3½	do	Nashville, Tenn., Montgomery, Ala., and Atlanta, Ga.
Pierce & Duffryn mine, Pierce seam.	Warrior	J. Pierce	20,000	3	Bituminous, best for steam	Atlanta, Columbus, Montgomery, and Nashville.
Pratt mines, Pratt seam	Pratt mines	Pratt Coal and Coke Co.	89,500	4¾	Bituminous, soft, coke, and steam.	Furnaces and R. R. in Alabama.
Alabama Mining and Manufacturing Co.	Warrior	Ernst and Rupp	11,788	2¾	Bituminous	S. and N. Ala. R. R., Selma, Montgomery, Mobile, Ala.; Pensacola, Fla.; N. Orleans, La., and various places in adjoining states.
New Castle C. and I. Co., Black Creek and New Castle seams.	New Castle	New Castle C. and I Co.	33,106	9		Alabama, Pensacola, Fla., Atlanta, Columbus, Macon, Pulaski, Columbia Franklin, and Nashville, Tenn.
	MADISON COUNTY.					
.....	.....	B. A. Simler	400	.....	Bituminous	Huntsville, Ala., by wagons.
.....	.....	Jno. Broad	600	.....	do	Do.
.....	.....	John Sullivan	200	.....	do	Do.
	SHELBY COUNTY.					
Helena mine, Little Pittsburgh and Helena seams.	Helena	Pratt Coal and Coke Co.	49,350	3-4 7	Bituminous, coke	Montgomery, Ala., East Georgia, and Alabama blast-furnaces
Montevallo mine, Montevallo seam.	Montevallo	T. H. Aldrich & Co	41,600	2½	Bituminous, hard, free-burning, non-coking, red ash.	Georgia, Alabama, and Mississippi.
North Cahaba mine, Cahaba seam.	Helena	Davis & Carr	4,500	3	Bituminous, domestic	Montgomery.
	TUSCALOOSA COUNTY.					
Johnson mine	Coaling	N. D. Johnson	12,000	2½	Bituminous, soft	Ala. Gt. So. R. R. and Mobile and Ohio R. R.
.....	Clement station	O. M. Collins	600	.....	Bituminous	
.....	.....	A. Durie	2,000	.....	do	Tuscaloosa, Ala., by wagons.
.....	.....	Gabe Washington and others.	350	.....	do	Neighborhood.
.....	Cottondale	Wiley Thompson	600	18	do	Cottondale factory, by wagons.
Chamber's mine	Near Tuscaloosa	Freeman Kelley and others.	340	.....	Bituminous, soft red ash	

ARKANSAS.

	JOHNSON COUNTY.					
.....	Grand and Prairie townships.	Allister & Allister	3,000	.....	Bituminous	Little Rock, Ark., by R. R.
.....	do	Kline & Arbaugh	6,240	.....	do	Do.
.....	do	Strewel & Siegel	313	.....	do	Do.
.....	do	Edw. S. Stienel	1,200	.....	do	Do.
.....	do	Bryan & Co	180	.....	do	Do.
.....	Lee township	L. S. & S. Philpot	300	.....	do	Russellville, Ark., by R. R.
	POPE COUNTY.					
.....	Illinois township	Onita Coal Co	1,600	2	do	Little Rock, Ark., by R. R.
.....	do	William Brooks	280	3	do	Dardenelle and Russellville, Ark., by wagon.
	SEBASTIAN COUNTY.					
.....	Sugar Loaf township	Isabel Spessard	300	.....	do	Sebastian county, Ark., by wagon.
.....	do	John Patterson	500	.....	do	Do.
.....	Marion township	Enoch B. Petty	375	.....	do	Fort Smith, Ark., by wagon.
.....	do	William J. Smart	250	.....	do	Do.
	WASHINGTON COUNTY.					
.....	Prairie township	Nancy Shepherd	80	7½	do	Hindsville, Ark., by wagon.
.....	do	John Ivy	160	1½	do	Springdale, Ark., by wagon.

Directory of bituminous coal mines—Continued.

CALIFORNIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	AMADOR COUNTY.			*Feet.*		
Ione C. and I. Co.'s mine	2½ miles south of Ione city.		60,480	10–20	Low order of lignite	San Francisco, Sacramento, Goshen, Stockton, Mercer, and other places.
Carbondale mine	6 miles northwest of Ione city.		25,200		Lignite	Do.
	CONTRA COSTA COUNTY.					
Empire Coal mines, Clark, Little, and Black Diamond seams.	6 miles south of Antioch.	M. W. Belshaw & Co	22,400		Bituminous, non-coking	San Francisco, Antioch and C. and P. R. R., via Co.'s R. R. and barge.
Pittsburgh mine, Clark, Little, and Black Diamond seams.	6 miles from Pittsburg Landing.	Stevens, Baker & Co	39,239		Lignite, non-coking	San Francisco, Sacramento, places about the bay, and Stockton, by rail and barges.
Black Diamond mine, Clark, Little, and Black Diamond seams.		Black Diamond C. Min. Co.	88,847	12¼	Bituminous, non-coking	Blk. Diamond and San Francisco, by rail and barges.
	LOS ANGELES COUNTY.					
Santa Clara mine	12 miles east of Santa Ana.	Southern Pacific R. R. Co.	784	2½	Bituminous	Los Angeles, by wagon.
Black Star mine	8 miles west of Silverado.	Jos. Yoch	None.	14–18	Bituminous, non-coking	Santa Ana, Los Angeles, and Anaheim.

COLORADO.

	BOULDER COUNTY.					
Black Diamond mine	6 miles from Boulder	William Slimpson	900	2–10	Lignite, non-coking	Boulder and Blackhawk.
Star Coal mine	Canfield	Star Consol'd C. Min Co.	17,000	15½	Lignite	Denver, Kansas, Boulder, Longmont, Greely, and Evans.
Superior mine, first and second seams.	1¼ mile south of Erie	Allen McNumee	1,750	8	do	Denver.
Fox mine	East of Marshall	M. P. Fox & Co	6,250	12	do	Denver, Boulder, and mountain towns.
Marshall mine	5 miles south of Boulder	Marshall C. Min. Co	50,000	2–12	do	Do.
Jackson mine	Canfield	Jackson C. Min. Co	None.		do	
Stewart mine	14 miles E. of Boulder	Stewart	1,700	3–5½	do	Denver.
Welch mine	¼ mile from Louisville.	Welch C. Min. Co	95,000	1–11	Lignite and bituminous, non-coking.	Col. C. R. R., Denver and mountain towns.
White Rock mine, top, sec-second, and third seams.	2 miles north of White Rock.	White Rock Coal Co	140	4⅝	Semi-bituminous, compact, hard, glossy.	Boulder.
	FREMONT COUNTY.					
Coal Creek Coal Co.'s mine	8 miles southeast of Cañon City.	Colorado C. and I. Co	88,323	3–5	Lignite, non-coking, of bituminous character; smelting works and domestic.	Denver, D. and R. G. R. R.
	GUNNISON COUNTY.					
Iowa Min. and Smelt. Co	½ mile from town, up Coal creek.	Iowa Min. and Smelt Co.	200	12–13	Bituminous, coking	Home market.
	HUERFANO COUNTY.					
La Veta C. Min. Co	¼ miles southwest of La Veta.	La Veta C. Min. Co	50	8	Bituminous	La Veta.
Walsenburg mine	1¼ mile west of Walsenburg.	Colorado C. and I. Co	26,880	4–9	Semi-bituminous, non-coking; steam.	Denver and R. G. R. R. Co., Pueblo, Col., Springs, Denver and Almosa.
Bundle mine	8 miles southwest of La Veta.	Bundle	None.	6–8	Bituminous, non-coking	La Veta.
	JEFFERSON COUNTY.					
		Chas. F. Thompson	250		Lignite	Transient custom.
Golden Brick and Coal Co.'s mine.	½ mile from center of Golden.	Golden Brick and Coal Co.	2,400	9–18	Semi-bituminous, semi-lignite, non-coking, white ash.	Central and Blackhawk, Georgetown, Golden; home consumption, and a little to Denver.
		Allen & Co	4,000		Lignite	Golden county.
		Nicholls & Hoagland	10,000		do	Do.
		Oliver Thomas, jr.	4,000	3½	do	Do.
	LA PLATA COUNTY.					
Ogden Coal Bank mine	5 miles east of Animas City.	P. Ogden	None.	5½	Bituminous, coking	
Durango Coal Bed mine	3 miles S. of Durango	Durango Trust Co	None.	34	Bituminous	
Mitchel Bed mine	5 miles below Parrott City.		None.	6½	do	
	LAS ANIMAS COUNTY.					
Rifenburg mine	2¼ miles NE. of Las Animas.	W. G. Rifenburg	20,160	15 1/12	Bituminous, coking	Topeka
Trinidad C. Min. Co	4 miles NE. of Trinidad	Trinidad C. Min. Co	20,160	7	do	Do.
Scandinavian Min. Co	4 miles from Trinidad	Scandinavian Min. Co	1,792	7	do	Do.
Carbon C. Min. Co	do	Carbon C. Min. Co	2,016	7	do	Do.

Directory of bituminous coal mines—Continued.

COLORADO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LAS ANIMAS COUNTY—continued.			*Feet.*		
El Moro mine	6 miles S. of El Moro	Colorado C. and I. Co.	58,904	18	do	D. and R. G. R. R., Pueblo, So. Ark., Denver, Col., Springs, Cañon, Almosa, Argo Smelt Works, Poncho Springs, and miscellaneous.
	OURAY COUNTY.					
Rico Coal claim mine, upper and lower seams.	8 miles N. of Rico		None.	3–14	Bituminous, non-coking	
	PARK COUNTY.					
S. Park Coal Co. mine	3½ miles from Como	South Park C. Co	4,032	13–16	Bituminous, coking and non-coking.	
	WELD COUNTY.					
Mitchel mine	1½ mile S. of Erie	Jos. Mitchel	15,480	15	Lignite	Denver and Greely.
Boulder Valley mine	On E. limit of Erie	Boulder Valley C. Co.	31,360	20–26	do	Denver, Greely, and Cheyenne.

GEORGIA.

	DADE COUNTY.					
Castle Rock mine, Gordon seam.	Cole City	Dade Coal Co.	15,000	3	Bituminous	Atlanta and Chattanooga.
Dade mine, Brown seam	do	do	139,644	4	do	Atlanta, Chattanooga, and Rising Fawn furnace.

ILLINOIS.

	BROWN COUNTY.					
——, bottom seam	La Grange	Richard Eddy	400	2	Bituminous	Ill. River steamboats.
	BUREAU COUNTY.					
Friar Joblin mine, second seam.	Mineral	Friar Joblin	1,280	4½	do	Country and railroad trade into Iowa.
Walton mine, second seam	5½ miles from C. Hollow	A. W. Walton	2,500	4½	do	Local.
Bourbonais mine, No. 6 seam.	Lovejoy	Charles A. Barney	7,400	5	Bituminous, hard, bright	Wyanet, Buda, and country.
Neponset C. and Min. Co., No. 6 seam.	Neponset	Lathrop C. and Min. Co.	7,500	4½	Bituminous, soft	Burlington, Iowa, Aurora, Ill., line of C. B. and Q. R. R., and Nebraska.
Locey's mine, third seam		George H. Locey	2,000	3⅝	Bituminous, free from sulphur; will coke.	Chicago, Joliet, small towns, and river consumption.
Sheffield Min. and Trans. Co., second seam.	Sheffield	Sheffield Min. and Trans. Co.	20,000	4½	Bituminous	Local.
Dennis mine	do	H. Dennis & H. Cann.	640	4⅝	do	Do.
J. Nichols & Co.'s mine	Coal Valley	John Nichols & Co.	2,000	4½	do	Local.
Bierman's shaft	do	Jos. Fletcher	4,000	4	do	
Adair shaft	Selby township	Austin Adair	4,000	4½	do	Local.
		Jos. Seeton	1,000		do	
		V. Keisenberger	1,400		do	
		J. Vanbelzer	1,300		do	
		Thomas Squire	800		do	
		Wicklin & Fleming	3,000		do	
		James Rood	1,200		do	
		Peter Duncan	3,300		do	
	Concord township	Wood & Co	800		do	Buda and Sheffield, by wagons.
	do	Alfred Lyford	1,200		do	Concord township, by wagons.
	do	E. S. Humphrey	400		do	Do.
	CLINTON COUNTY.					
Trenton mine, No. 6 seam	Trenton	Joseph Hankee	40,000	5	Bituminous, soft, fatty	St. Louis, via Ohio and Miss. R. R.
	COLES COUNTY.					
Larimore mine	Morgan township		320		Bituminous	Home consumption.
	FULTON COUNTY.					
Heald's Strip mine, No. 4 seam.	Saint David's	A. W. Heald	4,000	4½	Bituminous	St. Paul and Minneapolis, Minn.
Canton mine, No. 4 seam	Canton	do	22,265	4½–5	do	Northern Iowa and Minnesota.
——, No. 2 seam	Lewistown	James Hunter	250	2½	do	Lewistown.
Bryant mine, No. 4 seam	Bryant	Bryant Coal Company.	40,000	5	do	C. B. & Q. R. R. Co.
Farmington mine, No. 5 seam.	Farmington	P. P. Chapman	12,000	4½	Bituminous, white or gray ash	Ill. and Northern Ohio.
Orion mine, No. 5 seam	Breed's station	G. W. Hindson	60,000	4½	Bituminous	Peoria and Cedar Rapids.
Breckenridge mine, Geological Survey, No. 41 seam.	Astoria	W. N. Emerson & Co.	33,949	6	do	C., B. & Q. R. R. Co., Moline, Sterling, Rock Island, Beardstown, Monmouth, Ill.; Burlington, Montrose, Iowa; Minneapolis, Minn., and Upper Miss. river boats.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	FULTON COUNTY—continued.			*Feet.*		
Jackson's Bank mine	Rawalt	William Jackson	1,200	4⅝	Bituminous	Canton and local farmers' trade.
Jones' Bank mine	do	L. L. Jones	3,000	4⅝	Bituminous, soft	Toledo, Peoria and Warsaw R. R.
Fernland mine	Rawalt station	J. R. Rawalt	7,000	4⅝	do	Cedar Rapids, Iowa, and southern Minn.
Canton Coal Co.'s mine, No. 4 seam.	Canton	Canton Coal Co	9,168	4⅝	Bituminous	Iowa and Illinois.
Cuba mines, No. 4 seam	Cuba	Cuba Mine C. Co	11,747	4⅝	Bituminous, soft	Burlington and Keokuk, Iowa.
Sunny Side mine, No. 4 seam	Canton	J. & R. Saville	1,927	5	do	Canton and local.
Rutherford mine	Cuba	William Rutherford	16,989	11	do	Peoria, Keokuk, Burlington, and east as far as Indiana.
Fulton mine, No. 4 seam	do	Dongald Stewart	14,610	4⅝	do	Iowa as far northwest as Cedar Rapids, and east to Chenoa.
Whitehead mines, upper and lower seams.	"Tater Hollow"	Mark Whitehead	1,600	5½	Bituminous	Prairie City and Bushwell.
Saint David mine	Saint David	E. J. Williams	0,984	5	do	Burlington and Quincy.
Green mine	Farmington	Peleg Green	800	5	Bituminous, soft	Farmington R. R.
Civer Coal Co.'s mine, No. 5 seam.	Civer	Proctert Heald	3,600	4⅝	Bituminous	Peoria, Burlington, and Keokuk.
Kaffel mine	Farmington	William Kaffel	800	5	Bituminous, soft	Farmington.
James Stevenson mine	do	James Stevenson	600	5	do	Do.
Cook mine	3 ms. SW. of Vermont.	Eli. Cook	250	2⅝	do	Vermont.
Walker mine	Vermont	Wesley Walker	300	2⅝	do	Do.
William J. Larrimore mine	do	William J. Larrimore	300	2⅝	do	Do.
Dickson's shaft	Farmington	Thomas Dickson	1,000	5	do	Farmington and C., B. and Q. R. R.
Ferguson mine	do	A. Ferguson	400	5	do	Farmington.
John Kirkbride mine	Vermont	John Kirkbride	900	2⅝	do	Vermont.
Rutherford mine	Seville	Wm. Rutherford	560	4	do	Keokuk, etc.
Wadkin's shaft	do	John Dougherty	1,000	3	do	Keokuk and Warsaw.
Hood mine	4 ms. SE. of Bushwell	John Hartman & Co	2,500	3½	Bituminous, soft, nearly free from sulphur.	Bushwell.
"Orr's Bank" mine	Near Manetta	Robert Orr	600	2½	do	Do.
Iron's shaft	Seville	Hedden, Flood & Albert.	2,404	4	Bituminous, soft	Keokuk, Iowa, and other towns in the West.
Smith mine	Breed's station	W. H. Smith	2,100	4	do	Canton, Pekin, and Peoria.
Canon's shaft	Seville	N. Canon	1,815	4	do	Keokuk and Bushwell.
Grove mine	Canton	Lewis F. Bell	1,100	4½	Bituminous	Canton.
Ditch's shaft	do	E. F. Ditch	1,400	5	Bituminous, soft	Do.
Swanson's shaft	Table Grove	Charles Swanson	160	2½	do	Table Grove.
	Bryant	Jud & Goudy	40,000		Bituminous	
Wilcox mine	Lewistown	H. Upright	600		do	Lewistown, Ill.
	Fairview	Thomas Travers	1,100		do	
	Avon	Mr. Standard	400		do	
	do	Amos Wilson	400		do	
	Marietta	John Roebottom	1,600		do	
	do	John Henderlerton	400		do	
	do	Havens	400		do	
	do	M. Clark	400		do	
	do	Bartlett	400		do	
	Lewistown	Edw. Murer	600		do	
	do	Frank Bearce	775		do	
	do	Duncan	600		do	
	do	Henry Harnier	1,200		do	
	do	Winchell	700		do	
	do	John Arnott	600		do	
		John Harn	2,000	5½	do	St. Paul, Minn., by rail.
		James Whitehead	500	4	do	Home.
	Canton	David Auld	2,496		do	Canton, Ill., by wagon.
	Joshua township	John Bennett	2,000	5	do	Do.
	do	William H. Murphy	2,000	5½	do	Do.
	GALLATIN COUNTY.					
Bowlesville Mine Co., No. 9 key seam.	Bowlesville	Stock company	35,000	4⅝	Bituminous, soft, fatty	Ill. div'n of Ohio and Miss. R. R. and private consumers on line, and steamers on Ohio river.
	do	Abraham David	400		Bituminous	Shawneetown, by wagons.
Equality Coal Co's mine, No. 5 seam	Equality	Equality Coal Co	45,000	5	Bituminous, soft, strong, clear	St. Louis, and Evansville, Ind.
	GREENE COUNTY.					
Roodhouse mine, No. 6 seam	Roodhouse	William Bates	1,400	2⅝	Bituminous, soft	Roodhouse.
	Near Greenfield	Carter & Drake	800	3	Bituminous, soft, fatty	Neighborhood.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	GRUNDY COUNTY.			*Feet.*		
Rock's shaft	Morris	Henry Rock	200	2⅝	Bituminous	
Telfer's shaft	do	Aw. Telfer	None	2½	do	Local.
George shaft No. 2	do	William George	700	2½	Bituminous, soft	Do.
McBride's shaft	do	Rulison & Carr	700	2½	do	Do.
Gorridge shaft	do	S. P. Colsen	600	2½	do	Do.
Olendroff shaft	do	Henry Olendroff	600	2½	do	Do.
Watson shaft	do	Anthony Watson	450	2½	do	
Mrs. Pratt's shaft	do	Charles Conalem	400	2½	do	Do.
Gould Ridge mine	do	Gould Ridge Coal Co	30,000	3	do	Chicago.
George Blair's shaft	do	George Blair	600	2½	do	Local.
O. K. shaft	do	Burrell, Ross & Co	6,000	2	Bituminous	Chicago.
Burrell & Co.'s No. 1 mine	do	Burrell & Co	24,000	3	Bituminous, soft	Do.
Brace C. Min. and Mfg. Co	Braceville	Brace C. Min. and Mfg. Co.	20,000	3	do	Chicago and intermediate points.
Steele shaft	⅜ of a mile north of Morris.	John Steele	400	2½	Bituminous	
No. 3 mine	Coal City	M. D. Buchanan	88,362	3	Bituminous; railroad and manufactories for steam.	Chicago and all points west and north.
Sufferin mine	do	William B. Sufferin & Bro.	3,000	4¼	Bituminous	Chicago.
Hank shaft		Hank	3,000		do	
Clark shaft	Greenfield	William Clark	1,000	3	do	Country trade.
	Saratoga	E. Waterman	700	2½	Bituminous, soft	Morris, Illinois, by wagons.
	do	Alex. Telfer	2,000	2⅝	do	Chicago, Joliet, and Morris, by rail and canal.
	Greenfield	O'Mara & McConnel	500		do	Farmers.
	HENRY COUNTY.					
Round Grove mine	Burns	John Rockford	973	4½	Bituminous	Country trade.
Lathrop C. and Min. Co., No. 6 seam.	Kewanee	Lathrop C. and Min. Co.	56,000	4	Bituminous, soft	C., B. and Q. R. R. from Burlington, Iowa, to Aurora, Illinois.
Plumbtree shaft, top seam	Kewanee	E. Plumbtree	480	4	Bituminous	Country trade.
Kay's Bank mine, first seam	Atkinson	James Kay	1,200	3	do	Do.
Cambridge mine	Cambridge	J. W. Burton	1,600	2⅝	Bituminous, hard	Cambridge, Ill.
Cleveland C. Co.'s mine	Cleveland	Cleveland C. Co	10,951	4⅝	Bituminous	C., B. and Q. R. R. routes, Chicago and northwestern local trade.
Briar Bluff mine, No. 1 seam	Briar bluff	Perry & Co	20,000	4	Bituminous, soft	Chicago, Burlington and Quincy R. R. and N. W. R. R., and local trade.
White Collar mine, second seam.	Green River	Green River Min. Co	7,000	4–6	do	Moline, Rock Isl., and state of Iowa.
Galva Min. Co., first seam	Galva	Sundguist & Herdeen	4,202	3⅝	Bituminous	Galva and vicinity.
Lewin, Corkill & Co.'s No. 1 mine, first seam.	do	Lewin, Corkill & Co	3,800	4	Bituminous, soft	Do.
Lewin, Corkill & Co.'s No. 2 mine, first seam.	do	do	6,539	4	do	Galva, Cambridge, and vicinity.
Cleveland mine	Cleveland	Taylor Williams	15,000	4½	Bituminous	N. W. R. R., and Chicago, Burlington and Quincy R. R., and Sterling.
Aldrich mine	Hanna	M. M. Aldrich	1,600	4½	do	
Cambridge Coal Co.'s upper seam.	Munson	C. W. Fogg	1,050	3	do	Local farm trade.
White Collar mine, second seam.	Green River	S. P. Campbell	6,000	4	do	Geneseo, Moline, Iowa City, Homestead, and So. Wilton.
Down's Bank mine	Edford	Downs & Co	500	3½	Bituminous, soft	
	Kewanee	Samuel Charles	800	4	Bituminous	
	do	William Martin	400	4	do	
	do	Robert Price	800	4	do	
	do	B. Kirley	600	4	do	
	do	William Garland	400	4	do	
	do	Thomas Earl	1,000	4	do	
	Burns	J. Hadzell	1,500	4	do	
	Kewanee	J. Cater	400	4	do	
	Atkinson	William Delaney	1,000	4	do	
	do	J. Witherspoon	800	4	do	
	do	Thomas Frew	800	4	do	
	do	Mawbreny & Co	1,500	4	do	
	do	E. G. Ball	1,000	4	do	
	Geneseo	Clinton Ague	2,500	4	do	
	Osco	Yotkey Bros	1,000	4	do	
	Galva	John Dorr	600	4	do	
		Wm. Newton	1,200		do	Country trade.
	Munson	Faulkes & Co	700	2⅝	do	Geneseo and vicinity.
	do	Chas. Wood	700	2¾	do	Cambridge and vicinity.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	JACKSON COUNTY.			*Feet.*		
Lewis mine, No. 2 seam	Murphysborough	Lewis Coal Co	37,583	6½	Bituminous, hard, strong, resembles block coking.	St. Louis., Mo., via Cairo and St. L. R. R.
Campbell mine, No. 2 seam	Seven miles from Gillsburgh.	Wm. Campbell	160	3½	Bituminous, soft, open-burning.	Vicinity.
Harrison shaft, No. 2 seam	Harrison	Carbondale Coal and Coke Co.	114	6	Bituminous, lean, semi-block, hard.	St. Louis, Mo.
Crane mine, No. 2 seam	Crane Hill	Ashba Crane	136	4½	Bituminous, open-burning, somewhat soft.	Vicinity.
Brush mine, No. 2 seam	Carbondale	Sam'l T. Brush	1,600	4½	Bituminous, dry, open-burning.	Carbondale.
Briar Hill mine, No. 2 seam		Carbondale Coal and Coke Co.	3,564	2½	Bituminous, hard	St. Louis, Mo.
Zimmerman mine, No. 2 seam.	De Soto	Geo. T. Jones	320	9	Bituminous, semi-block, hard, bright, open-burning.	Vicinity.
Smith Coal quarry, No. 2 seam.	Ava	H. C. Brownfield	400	6	Bituminous, open-burning	Do.
Gartside mine No. 2	Murphysborough	Gartside Coal Co	19,495	6	Bituminous, resembles block coking.	St. Louis, Mo.
Downem mine, No. 2 seam	Campbell Hill	Dan'l Dawson	640	2½	Bituminous, soft, open-burning.	Vicinity.
Cheatham mine, No. 2 seam	Ava	H. C. Brownfield	400	6½	do	Towns along Cairo and St. Louis R. R.
	JERSEY COUNTY.					
	Brighter	B. Weber	300	3-4	Bituminous, soft, fatty	Neighborhood.
	do	Geo. Caims	800	3-4	do	Do.
	JOHNSON COUNTY.					
Burnside mine, Conglomerate seam.	New Burnside	Jas. A. Viall	27,000	3½	Bituminous, soft, fatty	Cairo, Vincennes, and Iron Mt. R. R.
	KANKAKEE COUNTY.					
Conklin mine	Essex	Story & Dobbs	1,600	2⅝	Bituminous, soft	Farmers and country trade.
	KNOX COUNTY.					
Campbell shaft	Wataga	R. M. Campbell	1,280	4½	Bituminous, soft	Local trade.
Old Whitehead mine	do	Louis Nodine	1,334	4½	do	Wataga and vicinity.
Sparta mine	do	Dolan Walsh	2,000	4	do	Galesburgh, Monmouth, and vicinity.
William S. Lombard & Co. mine, second seam.	Soperville	W. C. Lombard	None.	5	do	Galesburgh and Henderson.
Pilot Run mine, upper seam	Altona	George L. Clifford	5,291	4⅜	Bituminous, soft, free-burning.	Home, southern part of Henry county, northern part of Knox county.
Pilot Run mine, second seam	Oneida	do	5,292	4⅜	Bituminous	Do.
Donaldson shaft	Sparta township	Olaf Walene	1,500	4½	do	Local trade.
	Saluda		1,000		do	
	Henderson	Peter S. Tryner	600		do	
	do	Thomas Muir	150		do	
	do	—— Peterson	600		do	
	do	—— Beard	600		do	
Powers Coal Bank mine	do		300		do	
Two small mines	Oneida		1,500		do	
	Orange township	James Randall	600		do	Knoxville, Ill., by teams.
	do	Henry Caulkins	480		do	Do.
	Knox township	Thomas W. McGill	300		do	Galesburgh, Ill., by teams.
	do	Samuel H. Harper	500		do	Knoxville, Ill., by teams.
	do	James Nelson	600		do	Do.
	Indian Point	J. H. Miller	325		do	Abingdon and vicinity, by teams.
	do	John Cox	400		do	Sec. 23, by teams.
		Charles Lucan	300		do	Home trade, by teams.
	Maquon township	William Anderson	360		do	Farmington, by teams.
	LA SALLE COUNTY.					
Coal Run Coal Co.'s mine	Streator	Coal Run Coal Company.	60,000	5	Bituminous, soft	Chicago and Joliet, via C., B. and Q. R. R., C. P. and S. W. R. R., and C. and A. R. R., and Wabash, St. L. and Pacific.
Kentucky, Carbon or Rockville, La Salle or Taylor mines, second and third seams.	La Salle	Young trustees	40,000	7	Bituminous, domestic and steam.	Chicago, N. Ill., S. W. Wis., and N. E. Iowa, via Chi. R. R. and canal, Ill. C. R. R., C., R. I and P. R. R.
Streator Coal Co.'s mine	Bruce township	Streator Coal Co	56,030	4½	Bituminous, soft	Joliet, via Chicago and Alton R. R., and east, via Mich. Central R. R.
Nos. 1, 2, and 3 shafts	Streator	Chicago, Wilmington, and Vermillion Coal Co.	349,072	5½	do	Lines of C., B. and Q., C. and N. W., C., P. and S. W., and C. A. and St. L. R. R.
James Cahill mine, third seam	Peru	James Cahill	15,000	3½	Bituminous	
Union Coal Co.'s mine, second and third seams.	do	Union Coal Co	35,000	4½	do	Chicago and Peru.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LA SALLE CO.—cont'd.			*Feet.*		
Sample's mine, upper seam	South Streator	William Sample	2,000	4⅝	Bituminous	Local farmers and others.
Stoneham's shaft	Streator	John Stoneham	2,000	5	Bituminous, soft	
Evans' shaft	do	Richard Evans	10,000	4⅝	do	Chicago and places east as far as Indiana.
Helms' shaft	One mile southwest of Streator.	Alex. Helms	9,000	5	Bituminous	Aurora, Chicago, and shipments north and south.
	Streator	J. Eades & Son	None.	5⅝	do	Chicago.
Weidknecht mine	Buffalo Rock	William Weidknecht	300	1¾	Bituminous, soft	Local.
Vanslack mine	Streator	S. H. Vanslack	3,600	5½	do	Do.
Shelton shaft	Marseilles	Shelton & Sons	5,500	3	do	Marseilles.
McGarry shaft	Streator	George Alexander and Richard Finn.	7,500	4½	do	Aurora, etc.
Oglesby mine, second and third seams.	Oglesby	Oglesby Coal Co	40,000	9 1/12	do	Ill. Cen. R. R. north to Southern Minn., and as far as Beloit in Wisconsin.
Catrill mine, third seams	Peru	James Catrill	9,148	3½	do	Chicago, Moline, and other places on Chi., R. I. and R. R. R.
Caledonia mine	La Salle	Mitchell, Duncan & Lumsden.	5,715	5½	do	Ill. Central R. R.
Matthiessen & Hegeler mine, second seam.		Matthiessen & Hegeler		4⅝	Bituminous	Own smelting works at La Salle.
Zinc Co.'s mine	La Salle	Zinc Co	51,322			
Murray mine, second seam	Dimmock	Thomas C. Murray	400	4½	Bituminous, soft	Local.
Gatiss mine, second and third seams.	do	R. Gatiss	500	2⅝	do	Do.
Smith's Bank mine	Buffalo Rock	William Smith	200	20	do	Do.
Lipprant mine	Streator	H. Lipprant	4,000	5½	do	Chi., Ottawa, and other towns on C., B. and Q., and Wabash, St. L. Pac. R. R.
Fairburn mine	do	Robert Fairburn	1,400	4½	do	Local.
Crews' shaft	do	Joseph Crews	2,100	5	do	Streator and neighboring towns.
No. 2 mine, second seam	Peru	Union Coal Co	2,000	4	Bituminous	Chicago.
	Prairie Creek	J. C. Campbell	700	5	do	Surrounding country.
Maher's shaft	Rutland	William Maher	500	3½	Bituminous	Local.
	Near Ottawa	Pat Cannon	400	1½	do	
	Dear Park	Halderman Bros	900		do	Country trade.
	do	Jos. Broker	500		do	Do.
	LIVINGSTON COUNTY.					
Williams shaft	Two miles south of Streator.	John Williams	600	4¾	Bituminous, soft	
Hayson mine	do	Jos. Hayson	400	4½	do	Local.
John Kangley & Co. mine	Streator	John Kangley & Co	80,000	5	Bituminous	Chi., C., B. and Q. C. A. C. P. and S.W. R. R.
Moon shaft	Two miles south of Streator.	R. Finner	3,240	4½	do	Country trade.
Mallory shaft	Southwest of Streator.	Thomas Edwards	600	4⅝	do	Do.
Pontiac mine, second and third seams.	Pontiac	W. H. Levers	2,500	7½	do	Local.
Marshfield mine, top and lower seams.	Fairbury	John Watson & Son	1,500	7	Bituminous, soft	Surrounding country and towns having no shafts and railroads.
Central mine	do	Walton Bros	12,080	4½	Bituminous	Wabash R. R. and towns along line.
East Fairbury mine	do	John Gibb	14,210	4½	do	Do.
Edwards mine	Two miles south of Streator.	T. Edwards	600	4⅝	Bituminous, soft	
	New township	M. Peters	2,500		Bituminous	Streator, Ill.
	LOGAN COUNTY.					
Lincoln C. Min. Co	Lincoln	Lincoln C. Min. Co	60,000	5½	Bituminous, hard	C. and A. R. R. and local trade.
	McDONOUGH COUNTY.					
Milliken's mine, Colchester seam.	Colchester	George Millikens	821	2½	Bituminous, free from sulphur and all other minerals, blacksmithing.	Quincy, Ill.
William Egerton mine, Colchester seam.	do	William Egerton	4,450	2⅝	Bituminous, free from sulphur, blacksmithing.	Do.
Quincy Coal Co., Colchester or No. 2 seam.	do	Quincy Coal Co	55,000	2½	do	Quincy and various other towns.
Colchester Coal Co.'s mine, Colchester seam.	do	Colchester Coal Co	8,473	2½	Bituminous, free from sulphur.	Quincy and other more distant towns.
	Near Bushnell	John Hood	600	3	Bituminous	
	One half mile north of Colchester.	John McGran	400	2½	do	
	do	John Spicer	400	2½	do	
	One mile northeast of Colchester.	William McIntosh	800	2½	do	

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	M'DONOUGH CO.—cont'd.			*Feet.*		
.....	One and a half miles north of Colchester.	William Williams	600	2½	Bituminous	
.....	do	Lewis Lewis	1,200	2½	do	
.....	One-half mile northwest of Colchester.	Michael Hume	500	2½	do	
.....	Near Colchester	John King	600	2½	do	
.....	Three miles west of Colchester.	John Zimmerman	720	2½	do	
.....	One mile west of Colchester.	Fred Vogler	500	2½	do	
.....	One and a half miles north of Colchester.	George Brent	500	2½	do	
.....	Two miles north of Colchester.	Newman Foster	800	2½	do	
.....	Three miles northwest of Colchester.	John McClure	800	2½	do	
.....	Colchester	William Bright	750	2½	do	
.....	Near Colchester	Benjamin Nelson	600	2½	do	
.....	do	William Hodges	1,000	2½	do	
.....	Prairie City	Charles Millet	1,000	1⅝	do	Town and vicinity.
	M'LEAN COUNTY.					
McLean Co. C. Co.'s mine, second and third seams.	Bloomington	McLean Co. Coal Co	63,000	6	do	Central Ill.
	MACOUPIN COUNTY.					
South shaft, No. 6 seam	Carlinville	Bartels & Son	2,400	7	Bituminous, soft, fatty	Carlinville.
Virden mine, No. 6 seam	Virden	John W. Utt	38,309	7½	do	Jacksonville, Ill., C. and A. R. R.
Carlinville mine, No. 6 seam	Carlinville	Carlinville C. Min. Co	15,874	6	do	Towns along C. and A. R. R.
Neil mine, No. 6 seam	Bunker Hill	William Neil & Co	2,376	5½	do	Vicinity.
Staunton Coal Co.'s mine, No. 6 seam.	Staunton	Staunton C. Co	75,000	7½	Bituminous	St. Louis, Mo.
Girard mine, No. 6 seam	Girard	Girard C. Tile and Brick Co.	7,325	7	Bituminous, soft, fatty	Vicinity.
Weston mine, No. 6 seam	Staunton	Fritz Dingersen	520	6	Bituminous	Do.
Nilwood mine, No. 6 seam	Nilwood	H. Cooper & Sons	9,000	6	Bituminous, soft, fatty	Alton.
Mount Olive mine, No. 6 seam	Mount Olive	Mt. Olive Coal Co	95,000	7½	do	St. Louis, Mo.
.....	Bunker Hill	Albert Jones	1,000	5	do	Neighborhood.
Hodgers Creek mine	Near Chesterfield	D. R Coleman	400	.....	do	Do.
	MADISON COUNTY.					
Abbey mine No. 3, No. 6 seam.	Collinsville	Abbey C. and Min. Co.	37,056	6 7/12	Bituminous, soft, coking	St. Louis, Mo.
Reese mine, No. 5 seam	North Alton	Edw. Reese	2,400	2½	Bituminous, soft, fatty	Alton.
Dunford mine No. 1, No. 5 seam.	do	Henry Taylor	3,000	2½	do	Do.
Schrameck mine, No. 6 seam.	Edwardsville	Frank Schrameck	1,755	6	Bituminous, soft, fatty, coking.	St. Louis, Mo.
Worden mine, No. 6 seam	Worden	Worden Mining Co	921	7	Bituminous, coking	Do.
Taylor & Bro.'s mine, No. 5 seam.	North Alton	Taylor & Bros	1,656	2½	Bituminous, soft, fatty	Alton.
Collinsville C. and Min. Co., No. 6 seam.	Collinsville	Collinsville Coal and Min. Co.	48,000	7	do	St. Louis, Mo.
Camp mine, No. 5 seam	Godfrey	Henry Camp	1,600	2½	do	Alton.
Hughes & McGuire mine, No. 5 seam.	North Alton	Hughes & McGuire	600	2½	do	Do.
Heintz Bluff mine, No. 6 seam.	Collinsville	C. Heintz & Co	29,040	7½	Bituminous, coking	St. Louis, Mo.
Meyers mine, No. 5 seam	Bethalto	Michael Meyers	2,000	4	Bituminous, soft, fatty, very friable.	Vicinity.
Watts & Co. mine, No. 5 seam.	North Alton	Watts & Co	2,000	2½	Bituminous, soft, fatty	Alton.
Mrs. Smith mine, No. 5 seam	Edwardsville Junction	Margaret Smith	2,000	4½	do	St. Louis, Mo.
Conlen mine, No. 5 seam	North Alton	Peter Conlen	1,000	2½	do	Alton.
Cutcomb mine, No. 5 seam	do	Adolph Cutcomb	2,000	2½	do	Do.
Dunford mine No. 2, No. 5 seam.	do	E. Deere	4,000	2½	do	Do.
Mitchell mine, No. 5 seam	do	James Mitchell	3,675	2½	do	Do.
Rutledge mine, No. 5 seam	do	John Rutledge	1,936	2½	do	Do.
Robertson mine, No. 5 seam	do	Peter Robertson	2,160	2½	do	Do.
Wolf mine, No. 6 seam	Edwardsville	Wolf Bros	2,400	6½	Bituminous, coking	St. Louis, Mo.
Lumaghi mine, No. 6 seam	Collinsville	O. Lumaghi	25,228	7	do	Do.
Cantine mine, No. 6 seam	do	Cantine C. and Min. Co.	26,000	7½	do	Do.
Confidence mine, No. 6 seam	Confidence	Seybt, Bandalier & Co	46,092	7	do	Do.
Alton Summit mine, No. 5 seam.	Monticello	D. Noonan	1,200	2½	Bituminous, soft, fatty	Alton.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MADISON CO.—cont'd.			*Feet.*		
.....	Alton Junction	M. H. Boals & Co	878	2½	Bituminous, soft, fatty, little sulphur.	Own use.
.....	Fosterburgh	William Chalangworth	620	3½	Bituminous, soft, fatty	Neighborhood.
.....	Bethalto	C. H. Flick	1,640	3½	do	Do.
.....	Godfrey township	Dennis	3,000	2½	Bituminous	Alton, Ill
.....	do	Deere Eynon	3,000	2½	do	Do.
.....	do	Kamp & Co	700	2½	do	Do.
.....	do	Crowson & Watts	670	2½	do	Do.
.....	do	Hughes & McGuire	1,200	2½	do	Do.
.....	do	Kortkamka	1,500	2½	do	Do.
.....	Edwardsville city	M. Schmidt	3,000	.....	do	St. Louis, Mo.
.....	do	A. Schramek	9,000	.....	do	Do.
	MARION COUNTY.					
Sandoval C. and Min. Co 's mine.	Sandoval	Sandoval C. and Min. Co	3,463	5½	Bituminous, soft, fatty	St. Louis, Ohio, and Miss. rivers.
Centralia mine, No. 6 seam	Centralia	Centralia Min. and Mfg. Co.	36,480	7	Bituminous, fatty	Towns along Ill. Cen. R. R.
	MARSHALL COUNTY.					
Saville mine	Near Sparland	Charles Saville	1,800	3⅔	Bituminous	Lacon.
.....	Sparland	Kelly & Flynn	450	3⅔	do	
.....	do	David Mathias	450	3⅔	do	
	MENARD COUNTY.					
North shaft	Petersburgh	C. B. Laning & Co	40,000	6	Bituminous	R. R.
Junction Coal shaft	do	T. F. Laning	5,000	6–6½	Bituminous, not very soft	Towns on C. and A. and Springfield and N. W. R. R.
Rose Hill mine	do	William Landon	320	5–6	Bituminous	Petersburgh.
South Valley mine	Tullula	W. G. Greene	3,500	6	do	Local and C. and A. R. R.
Tulsner mine	Petersburgh	W. Tulsner	200	6	do	Local.
Tullula shaft	Tullula	C. B. Laning	10,900	6	do	C. and A. R. R.
Athens C. shaft	Athens	William Parkins	1,200	6	do	Local.
	MERCER COUNTY.					
Slope No. 1 mine	Cable	Coal Valley Min. Co	59,366	3–4½	Bituminous, soft	Rock Isl., Ill., Davenport and Iowa City, Iowa, to R. R. via Rock Isl. and Mercer Co. R. R.
Isaacson mine	Parker run	J. M. Isaacson	1,075	2½	Bituminous	New Windsor, Albany and Offham.
Harriott mine	Viola	W. W. Pinkerton	3,000	4	do	Local.
Bunker Hill mine	Cable	Richard B. Ellis	9,000	4	Bituminous	Local and country trade, Rock Island and Davenport.
Camp Creek mine	Near Millersburg	L. R. Hyett	1,200	3	do	Millersburg, Aledo and Hamlet.
H. Fowler mine	Camp creek	H. Fowler	160	2½	do	Millersburg and Duncan township.
Taylor mine	Coal Dale	Robert Taylor	2,000	4	do	N'thn part of Mercer Co. and st'hn part of Rock Island Co.
Griffin mine	Richland Grove township.	Griffin Bros	1,120	2½	Bituminous, soft coking, free from pyrite.	New Windsor and country trade.
Old Dunlap mine	Four miles northeast of Aledo.	Geo. Langston and Ben Boden.	240	.....	Bituminous	Aledo and farmers.
Edwards Creek mine	Green's township	Edward Heggs	480	.....	do	Aledo, Ill.
.....	Aledo	D. Welsh	600	.....	do	
.....	Perryton	Squire Butcher	500	3	do	Do.
	MONTGOMERY COUNTY.					
Litchfield mine, No. 5 seam	Litchfield	Litchfield Coal Co	42,400	4	Bituminous, hard	St. Louis, Mo.
	MORGAN COUNTY.					
Thompson shaft	Three miles north of Neelyville.	John Thompson	1,500	4	Bituminous	Local country trade.
Neelyville mine	Neelyville	J. D. Crabbe	12,000	4½	do	Quincy, Keokuk, Hannibal, &c.
	PEORIA COUNTY.					
Adam Sholl mine, middle seam.	Sholl's siding	Adam Sholl	23,400	4½	Bituminous, soft, almost free from pyrite.	Peoria, Pekin, and line of P., P. and J. and P., D. and E. R. R.
Wilkinson & Wanthing mine, No. 4 seam.	Edwards station	Wilkinson & Wanthing.	30,000	4½	Bituminous, hard	Iowa and Minn.
Allen mine	Limestone township	Edward Allen	3,756	4½	Bituminous, medium	Peoria, Ill.
Monroe mine	do	Jas. Monroe	6,000	4½	Bituminous	Do.
Hollis mine	Hollis	Carter & Hamilton	7,200	4½	Bituminous, soft	Peoria, Pekin, and Jacksonville.
Jones mine	Mapleton	E. J. Jones	3,200	4½	Bituminous	Peoria.
Orchard mine	Hollis	Newsan Bros	14,228	4½	do	Iowa as far NW. as Cedar Rapids, and some to Nebraska.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	PEORIA CO.—cont'd.			*Feet.*		
East Mapleton mine, No. 4 seam.	Mapleton	Frank Newsan	9,200	5½	Bituminous, soft	Iowa as far west as Cedar Rapids and east Indiana.
Pottstown mine	Pottstown	Middleton & Co.	12,000	4	do	Some in Minn., Peoria, and Iowa as far west as Cedar Rapids.
Lancaster mine, third seam	Lancaster lands	Jeffard & Beathard	10,000	4½	do	Ill. river steamboats.
Elmwood mine, No. 6 seam	Elmwood	W. J. Phelps & Son	21,000	4½	Bituminous, soft coking	Chicago, Burlington and Quincy R. R. as far west as Burlington.
Linsley & Co. mine, No. 4 seam.	Mapleton	T. Linsley & Co	12,700	4⅝	Bituminous, soft	As far west as Cedar Rapids, Iowa, and Minneapolis, Minn., and Indiana.
Kramm's Station mine	Kramm's station	E. Kramm	20,400	4	Bituminous	Iowa as far west as Cresco, NW. as far as Austin, Minn.
Hayward mine, No. 6 seam	Brimfield	W. H. Langden & Son.	9,000	4½	Bituminous, soft coking	Burlington, Iowa; Keithsburg, Ill.; and C., B. and Q. R. R.
Brost mine	Dondalville	C. E. Brost	7,000	4½	Bituminous, soft	Peoria.
Ball mine	Peoria	Ball & Moffatt	6,170	4½	do	Peoria and local trade.
Royster Brothers' mine	Dondalville	Royster Brothers	2,400	4	do	Do.
Treashur mine	Near Peoria	Walter Treashur	5,840	4½	do	Peoria.
Noll & Fender mine	do	Noll & Fender	8,640	4½	do	Do.
Mulligan mine	4 miles west of Peoria.	Thomas Mulligan	1,000	4½	Bituminous	Do.
Grant mine	Dondalville	Peter Grant	2,380	4½	Bituminous, soft	Do.
Fred. Mohn mine	do	Fred. Mohn	1,200	4½	do	Do.
Griswold mine	4 miles from Peoria	Wolland & Co.	3,000	4½	Bituminous	Do.
Vickery mine	Kickapoo creek	Harry Vickery	2,000	3¾	do	Do.
Clifford, Abley & Co. mine	Pottstown	Clifford, Abley & Co.	3,000	4	Bituminous, soft	
Gilfay, Lindsay & Co. mine, No. 4 seam.	Mapleton	Gilfay, Lindsay & Co.	4,800	4⅜	do	Do.
Rutherford mine, No. 4 seam	Near Peoria	James Day	6,400	4½	Bituminous	Do.
	do	F. Lanner & F. Foviatt	3,000	4½	do	Do.
Blank mine	Peoria	George Blank	1,500	4½	do	Do.
Kingston mine	Kingston	Kingston I. and C. Co.	None.	4½	Bituminous, soft	
Collin & Gorman mine	3 miles west of Peoria.	Collin & Gorman	14,000	4	Bituminous	
	Peoria	Paddy Hoy	3,800		do	
	do	James Wait	2,000		do	
	do	William Randle	2,500		do	
	do	Jacob Slane	400		do	
	do	Donaldson & Royster	500		do	
	do	Kidder Est	500		do	
	do	Lanc. & Grishoft	600		do	
	Brimfield	James Park	400		do	
	do	William Hull	500		do	
	do	Charles Hays	700		do	
	do	John Ryon	500		do	
	do	Cyrus Brooks	400		do	
	do	John Tully	500		do	
	Mapleton	William Johnston	400		do	
	Elmwood	Thomas Hurf	1,000		do	
	do	John Concklin	1,000		do	
	do	Avery Dalton	1,800		do	
	Brimfield	Jos. Catton	1,000	4½	do	Brimfield, Ill.
	Peoria	Frank Englke	600		do	
	PERRY COUNTY.					
Frizell mine, No. 5 seam	Duquoin	Rogers & Co	15,590	6	Bituminous, hard, fatty	Duquoin.
Tamaroa mine, No. 5 seam	Tamaroa	David Thompson	15,969	5½	do	Towns along Illinois Central R. R.
Star mine, No. 5 seam	Duquoin	Star Mining Co	15,790	6	Bituminous, fatty, does not slack much.	Do.
Sun C. and Coke Co.'s. mine, No 5 seam.	Wall's End	Sun Coal and Coke Co.	23,267	5	Bituminous, hard, fatty	Do.
Saint John mine, No. 5 seam	Saint John	Ill. Cen., I. and C. Co.	113,987	8	do	Cairo, Ill.
Beaucoup mine, No. 5 seam	Pinckneyville	J. P. Cowens	9,875	6	do	St. Louis, Mo., via Cairo short line.
Cox mine, No. 5 seam	Tamaroa	P. White	9,200	5½	do	Towns along Illinois Central R. R.
Enterprise mine, No 5 seam	Duquoin	Enterprise C. and Coke Co.	14,660	6	do	Towns along Ill. Cen. R. R. and north.
Galum mine, No. 5 seam	Conant station	Barwell & Carter	2,442	6	Bituminous, somewhat hard.	St. Louis, Mo., via Cairo short line.
Hammrack mine, No. 5 seam	Pinckneyville	J. M. Bayless and W. S. Rice.	400	6½	Bituminous, somewhat hard, considerable sulphur.	Pinckneyville.
	do	Pat Malene	500	7½	Bituminous, soft, fatty	Neighborhood.
	do	Thomas McCann	506	7½	do	Do.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	RANDOLPH COUNTY.			*Feet.*		
Richey mine, No. 6 seam	Sparta	James A. Wilson	800	5½	do	Vicinity.
Roberts mine, No. 6 seam	do	John Roberts	700	5	do	Do.
Rosborough mine, No. 6 seam	Rosborough station	R. H. Rosborough	14,400	6	do	St. Louis, Mo., Cairo, and St. L. R. R.
Stanley mine, No. 6 seam	Blairtown	Geo. Stanley	800	5	do	Vicinity.
Weberling mine, No. 6 seam	Percy	A. G. Holley	144	5⅝	do	Do.
Gibson mine, No. 6 seam	Sparta	Jas. Gibson	400	5	do	Do.
Eden mine, No. 6 seam	Eden	Henry Martin	2,400	5½	do	Do.
Coultersville mine, No. 6 seam	Coultersville	Jones & Nisbet	17,891	6½	Bituminous, hard, fatty	St. Louis, Mo., via Cairo short line.
Boyd mine, No. 6 seam	Sparta	D. B. Boyd	5,328	5½	Bituminous, soft, fatty	Sparta and Red Bud, Ill.
Barnard mine, No. 6 seam	Percy	Barnard & Co	27,095	7	do	Miss. river steamboats at Chester, Ill.
	ROCK ISLAND COUNTY.					
Hampton Coal Mining Co	Hampton township	Hampton C. Mining Co.	33,040	4	Bituminous, soft, very little pyrite.	Sabula, Dubuque, Cedar Rapids, Freeport, Beloit, Racine, via. Chi., Mil. and St. P. R. R.
Black Diamond mine	Coal Valley	Black Diamond Mining Co.	12,000	4	Bituminous, soft	Rock Isl., Davenport, and Moline.
Hampton mine	Happy Hollow	Taylor Williams	35,000	4½	Bituminous	Chi. and N. W. R. R. Co., and Chi., Mil. and St. P. R. R. Co.
Binghampton mine	Coal Valley	Coal Valley Mining Co.	27,968	8	Bituminous, soft, containing sulphur.	Rock Isl., Davenport, Iowa City, and R. R. at Rock Island.
Bowles mine	Bowlesburg	Sam'l Bowles	3,500	4	Bituminous, soft	
Etna Coal Co.'s mine	Happy Hollow	Etna Coal Co	2,000	3½	do	Moline.
Donald & Brown mine	Bowlesburg	Donald & Brown	2,000	4	do	
Williams mine	Coal Valley	David Williams	450	4	do	Local.
Phillips mine	do	John H. Phillips	500	3½	do	Do.
Hunter mine	Moline township	Horace L. Hunter	560	4	do	Do.
Allison mine	Bowlesburg	Wm. Allison	800	4	do	Do.
Vonach mine	Coal Valley	Fred. Vonach	850	3½	do	Do.
Edward mine	do	David Edward	1,500	3½	do	Do.
Wilson mine	do	George Wilson	300	3½	do	Do.
Adams mine	do	Wm. Adams	408	4	do	Do.
Bowles mine	Bowlesburg	Sam'l Bowles	1,500	3½	do	Bowlesburg and Moline.
Hynd mine	do	John Hynd	2,300	3½	do	Moline.
Kay mine	do	Robert Kay	320	3½	do	Local.
Waulockhead No. 2 mine	Rapids City	H. W. Gilchrist & Co	None.	5	Bituminous, soft	Miss. river steamboats and towns on Miss. R., C., W., St. P. R. R.
Port Byron mine	do	Taylor Williams	41,000	4½	Bituminous	Upper Miss. river and C., M. and St. P. R. R.
Waulockhead No. 1 mine	do	H. W. Gilchrist & Co	29,300	4½–5	Bituminous, soft	St. Clair, Clinton, Davenport R. R., and Miss. river steamboats.
Porter mine	Bowlesburg	Porter Brothers	5,000	4	do	Moline.
	Hampton	Heagy & Stoddard	33,040		Bituminous	
	Edford	Downs & Co	500		do	
	Zuma township	Zuma Coal Co	400	3	do	Port Byron, Ill.
	Drury township	Stewart R. Drury	1,000	2½	do	Steamboats on Miss. river.
	do	John Wray	480	2	do	Muscatine, Iowa.
	do	Jere. Lequatte	936		do	Do.
	SALINE COUNTY.					
Ledford mine, No. 7 seam	Ledford Station	James A. Viall	2,000	5	Bituminous, soft, fatty	Cairo, via. C. and V. R. R
	SANGAMON COUNTY.					
Old North mine	Springfield	Beard, Hickox & Co	100,000	5⅜	Bituminous	Springfield City and Springfield I. Co.
West End mine	do	Charles R. Hunt	54,400	6	do	Springfield and Ohio and Miss. R. R., and towns thereon.
Sangamon mine, No. 5 seam	do	Stame, Dresser & Co	60,000	6	do	Ill. Cen. and Wabash R. R. as far north as Dubuque, west as Quincy and Hannibal, east as Fort Wayne.
Springfield Coop. C. Co.'s mine	do	Springfield Coop. C. Co.	33,683	5½	do	Springfield and Bloomington.
East coal shaft	do	Capital C. Co	37,836	5⅝	do	Springfield and Ill. Cen. R. R., and towns on lines as far east as Clinton.
Junction mine, No. 5 seam	Woodside township	Wabash Coal Co	53,000	6	do	Line of Wabash, St. L. and Pac. R. R.
Riverton mine	Riverton	Riverton and Junction C. Co.	40,000	5⅝	do	Line of Wabash R. R. as far east as Fort Wayne, west as Springfield.
Barclay mine	Barclay	Barclay Coal Co	45,000	5⅝	do	Ill. and Cen. R. R., and as far north as Chi.
Pleasant Plains mine	Pleasant Plains	John Galloway and others.	3,700	5½	do	Local trade.
	SCHUYLER COUNTY.					
Spiller mine	Frederick township	John Spiller	115	2½	Bituminous; blacksmith and steam.	Beardstown, Cass Co., and Frederick.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
				Feet.		
	SCHUYLER CO.—cont'd.					
Kerr mine	Rushville	John Kerr	1,750	5 5/12	Bituminous, bright, hard; considerable sulphur; steam.	Rushville.
Boyd mine	do	William Boyd	1,800	5½	do	Do.
	Pleasant View	Thomas Parks	400	5½	Bituminous	
	SCOTT COUNTY.					
Frost mine	Winchester	Charles Frost	3,700	2½	Bituminous	Local.
Five small drifts	Exeter		2,000	2½	do	
	SHELBY COUNTY.					
Brophy mine, No. 15 seam	Shelbyville	Michael Brophy	800	2½	Bituminous, soft, fatty, pliable.	Vicinity.
Richardson mine, No. 15 seam	do	John Richardson	2,000	2	do	Do.
Jonathan Minto mine, No. 15 seam.	Robinson creek	John Minto	1,000	2½	do	Do.
Kurtz mine, No. 15 seam	Shelbyville	C. J. Kurtz	804	2½	do	Do.
Robinson Creek mine, No. 15 seam.	Robinson creek	Thomas Minto	1,200	2½	do	Shelbyville and Pana.
		Thomas Hancock	400		Bituminous	Neoga, Illinois.
		John Young	300		do	Neoga, Sigel, and Stewartson.
	STARK COUNTY.					
Swanson mine	Wyoming	Jos. Swanson	2,000	4	Bituminous, soft	Wyoming.
Lathrop C. Min. Co.'s mine	do	Lathrop C. Min. Co	12,000	4	do	Towns in Stark county.
Bradford mine, Clay Band seam.	Spom river	William Himes	393	4	Bituminous	Country.
Taylor mine	Wyoming	William Taylor	800	4	Bituminous, soft	Wyoming and neighboring towns.
	do	Richard Howarth	800		Bituminous	
	Modena	John Scott	500		do	
	Elmira	James Green	800		do	Country trade.
	West Jersey	John Catton	800		do	Neighborhood.
		John O'Neil	1,200	4½	do	Toulon and at bank.
		William Newton	450	4½	do	Toulon and vicinity.
		William Shaw	400	4	do	Do.
		Linkin & Son	360	4	Bituminous, soft	Stark county.
		Andrew Beck	600		do	
	SAINT CLAIR COUNTY.					
Nichols mine, No. 6 seam	Lebanon	Jos. Morris	12,000	5	Bituminous, soft, fatty	St. Louis, via O. and M. R. R.
Bennet mine, No. 6 seam	do	Donnewald, Hering & Co.	16,000	5½	do	Do.
Reinecke No. 1 mine		Conrad Reinecke	15,266	6½	Bituminous, soft, fatty	St. Louis, via Louisville and Nashville R. R.
Western mine, No. 6 seam	Belleville	Western Mining Co	18,744	6½	do	St. Louis, Mo.
Kloess, Nos. 1 and 2 mines, No. 6 seam.	do	Jno. Kloess	15,249	6½	do	St. Louis, via St. L. and Ill. R. R.
Northwestern mine, No. 6 seam.	1 mile from Belleville	Northwestern C. Min. Co.	13,902	6	do	Do.
Harry Taylor mine, No. 6 seam.	West Belleville	Henry Taylor	14,000	6	do	Do.
Kline mine, No. 6 seam	Freeburgh	Simpson & Rauth	7,997	8	do	St. Louis, via Cairo short line.
Beatty mine, No. 6 seam	Belleville	Jas. Beatty	8,000	7	do	St. Louis, via Ill. and St. L. R. R.
Wilderman mine, No. 6 seam	Wilderman station	A. Danzer & Co	16,200	7	do	St. Louis, via Cairo short line.
Freeburgh mine, No. 6 seam	Freeburgh	Freeburgh Coal Co	12,870	8	do	Do.
Dudley mine, No. 6 seam	S. of Heinrich station	Dank, Bro. & Co	3,708	6	do	Do.
Rose Hill mine, No. 6 seam	West Belleville	Hazard, Wilson & Co	20,512	6	do	St. Louis, Mo., via Ill. and St. L. R. R.
Maule & Ganot mine, No. 6 seam.	Belleville	Maule & Ganot	9,600	7	do	Belleville and St. Louis, via Ill. and St. Louis R. R.
Dank No. 1 mine, No. 6 seam	Near Centreville station.	Dank Mining Co	35,330	6	do	St. Louis, Mo., via Cairo short line.
Great Western mine, No. 6 seam.	West Belleville	Henry Taylor	8,000	6	do	St. Louis, via Ill. and St. L. R. R.
Branch No. 2 mine, No. 6 seam.	Near Belleville	Krantz & Co	4,000	6½	do	St. Louis, via S. E. R. R.
Enterprise mine, No. 6 seam	Rentchler station	Adam Ogden	5,860	6	do	Do.
Emmet mine, No. 6 seam	Belleville	Dutch Hollow Coal Co	16,100	7	do	Do.
Pollack mine, No. 6 seam	Birkner station	Pollack Mining Co	4,400	6	do	Do.
Knicht mine, No. 6 seam	do	Dan'l Knicht	12,341	7	do	St. Louis, via Louisville and Nasville R. R.
Lenz mine, No. 6 seam	Dutch Hollow	August Lenz	None.	7	do	St. Louis, via S. E. R. R.
I. K. L. mine, No. 6 seam	Rentchler station	Philip Tisch	5,400	6½	do	Mascontah, Ill., via S. E. R. R.
Springwell mine, No. 6 seam.	Bartlett	Matthew Needham	33,361	6½	do	St. Louis, Mo.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
				Feet.		
	ST. CLAIR CO.—cont'd.					
Abbey No. 2 mine, No. 6 seam.	Abbeyville	Abbey Coal Mining Co.	27,100	6½	Bituminous, soft, fatty	St. Louis, Mo.
Brandenburger No. 2 mine, No. 6 seam.	West Belleville	Wm. Brandenburger	21,000	7	do	St. Louis, via Cairo short line.
Mine No. 1, No. 6 seam	Abbeyville	Abbey Coal Mining Co.	47,684	6½	Bituminous, soft, best steam and heating.	St. Louis, Mo.
Gartside No. 3 mine, No. 6 mine.	Gartside	Gartside Coal Co	16,651	6	Bituminous, soft, fatty	East St. Louis, Ill., and St. Louis, Mo.
Hazard & Wilson mine, No. 6 seam.	West Belleville	Hazard & Wilson	47,571	6	do	St. Louis, Mo., via Cairo short line.
Laurel Hill mine, No. 6 seam.	East Belleville	J. Beard and James Beally.	1,200	6½	Bituminous, soft, fatty	St. Louis, Mo.
Harmony mine, No. 6 seam	Letz station	S. A. Weissenbarn	24,561	6½	Bituminous	St. Louis, Mo., via Ill. and St. L. R. R.
Greenfield mine, No. 6 seam	West Belleville	Greenfield C. Co	12,000	5	Bituminous, soft, fatty	Do.
Stalberg mine, No. 6 seam	Belleville	John P. Heinrich	5,018	7	do	St. Louis, via Cairo short line, also Belleville.
Mulson or Reebs mine, No. 6 seam.	West Belleville	Nicholas Reeb	8,200	6½	do	St. Louis, via Cairo short line.
Schureman Bros. mine, No. 6 seam.	Reeb's station	Schureman Bros	18,999	6	do	St. Louis, Mo., via St. L. R. R.
St. Clair mine, No. 6 seam	One mile east of Caseyville.	George F. Savitz	9,734	5	do	St. Louis, Mo.
Union mine, No. 6 seam	Two miles east of Caseyville.	do	720	6	do	Do.
Van Courts mine, No. 6 seam.	One mile east of O'Fallon.	Savitz Bros	22,465	6	do	Do.
Cross-Roads mine, No. 6 seam	Firman station	Gartside Coal Co	10,080	7¾	do	Do.
Alma mine, No. 6 seam	Alma	do	64,943	6½	do	East St. Louis, Ill., and St. Louis, Mo.
Mascoutah mine, No. 6 seam.	Mascoutah	Mascoutah Coal Co	4,800	7	do	Mascoutah.
Lippert mine, No. 6 seam	Millstadt	Fred. & Jack Lippert	400	6½	do	Millstadt.
Muskopk mine, No. 6 seam	Centreville	Daniel Muskopk & Co.	500	6	do	Do.
Horttman mine, No. 6 seam.	North Belleville	Horttman & Co	6,000	6	do	Belleville.
Gellwicks & Richards mine, No. 6 seam.	Belleville	Gellwicks & Richards	1,859	6½	do	Do.
Yoch mine, No. 6 seam	Yoch station	James Yoch & Bros	26,976	6	do	St. Louis, Mo., via Ill. and St. L. R. R.
Johnson mine, No. 6 seam	Briar Hill	do	9,835	6	do	Do.
Briar Hill mine, No. 6 seam	do	John Beard & Co	9,304	5½	Bituminous, soft, strong, clear.	St. Louis, Mo.
Union mine, No. 6 seam	do	do	3,851	6½	do	Do.
Vulcan mine, No. 6 seam	Birkner station	Koelle Bros	7,000	6½	Bituminous, soft, fatty	St. Louis, Mo., via S. E. R. R.
Reutchler mine, No. 6 mine	Reutchler	D. Rinel Reutchler	5,109	6	do	St. Louis, Mo., via S. and N. R. R.
East Belleville mine, No. 6 seam.	One mile southeast of Belleville.	Hazard Wilson & Co.	6,000	6	do	St. Louis, Mo., via S. E. R. R.
Branch mine, No. 6 seam	Lenz station	Gartside Coal Co	748	6⅛	Bituminous, coking	St. Louis, Mo.
Padfield mine, No. 6 seam	Belleville	H. Padfield	2,259	6½	Bituminous, soft, fatty	Belleville.
Humboldt mine, No. 6 seam	West Belleville	John Schmidt	6,536	6½	do	St. Louis, Mo., via S. E. R. R.
Birkner mine, No. 6 seam	Birkner station	Birkner Min. Co	14,250	7	do	Do.
Reinecke No. 2 mine, No. 6 seam.	Belleville	Conrad Reinecke	30,532	7	do	St. Louis, Mo., via Louisville and Nashville R. R.
Dutch Hollow mine, No. 6 seam.	Birkner	Dutch Hollow C. Co	18,747	6	do	St. Louis, Mo., via S. E. R. R.
Excelsior mine, No. 6 seam	do	E. W. Harris	9,604	6½	do	St. Louis, Mo., via L. and N. R. R.
Ebner & Thomas mine, No 6 seam.	Belleville	Ebner & Thomas	4,400	7	do	St. Louis, Mo., via S. E. R. R.
Flanagan mine, No. 6 seam	S. Belleville	E. F. Flanagan	2,400	7	do	Belleville.
German mine, No. 6 seam	Belleville	John Herrst	4,000	7	do	Do.
Hollman & Rinther mine, No. 6 seam.	do	Hollman & Rinther	2,000	7	do	Do.
Winter mine, No. 6 seam	West Belleville	Wm. Ebel & Bros	2,000	6½	do	Do.
Pointer mine, No. 6 seam	Reeb station	Geo. Pointer	2,400	6½	do	Cairo short line.
Skellette & Co. mine, No. 6 seam.	do	Skellette & Co	12,657	6	do	St. Louis, Mo.
Victor mine, No. 6 seam	Birkner	E. W. Harris	12,023	6½	do	St. Louis, Mo., via L. and N. R. R.
White Oak mine, No. 6 seam.	White Oak	White Oak Coal Co	33,764	7	do	St. Louis, Mo., via Cairo short line.
Heinrich mine, No. 6 seam	Heinrich station	Heinrich Coal Co	34,926	6	do	Do.
Summit or Goably mine, No. 6 seam.	Ogle station	Kennedy Coal Co	15,719	6	do	Do.
Green Mount. mine, No. 6 seam.	1 mile from W. Belleville.	Weber & Co	12,000	7	do	St. Louis, Mo., via Ill. and St. L. R. R.
		St. Libory C. Min. Co	2,700	7	Bituminous	Johanesburgh, Darmstadt, and Heinrichtown.
		Jacob Lippert	2,000	6	do	Vicinity.
		Christian Fenerhan	2,200	6	do	Do.

Directory of bituminous coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	TAZEWELL COUNTY.			*Feet.*		
Wesley City Coal Co.'s mine.	Wesley City	Wesley City C. Co	16,000	4½	Bituminous	Peoria and surrounding country.
Wesley No. 1 mine	do	Russia Bros	2,200	4½	Bituminous, medium	Peoria.
Vogelsang's Lakeside mine	Hilton	J. G. Vogelsang	7,000	4½	Bituminous, very soft	Peoria City and Woodford and Tazewell Co's.
Hope mine	Pekin	D. M. Alexander	8,000	11½	Bituminous, soft	Pekin.
Halley mine	Hawleys	N. C. Hawley	6,400	4	do	South as far as Mattoon, and some east.
Victor mine	Pekin	Rundle & Good	6,000	4⅝	do	Pekin and local trade.
Murray's shaft	Hilton	Jas. Murray	2,300	4	do	Pekin.
Milliard's shaft	do	Jas. Milliard	3,000	4	do	Peoria.
Mrs. Hoffman's mine	Fondulac	Mrs. Hoffman	600	4	do	Do.
Leddemian mine	Pekin	Lord & McDougal	624	4	do	Pekin.
Ledterman mine	Three miles S. of Pekin	John B. Ledterman	6,000	4½	Bituminous	Do.
Lord & McDougal mine	Pekin	Lord & McDougal	624	4	do	Do.
Disshman mine	Three miles N. of Pekin	G. D. Disshman	1,200	4½	do	Pekin and country trade.
Stoner mine	do	Martin Jeungen	1,400	4½	do	Pekin and local trade.
	VERMILLION COUNTY.					
Martin mine, Danville seam.	Jordan	Charles Tilton	1,200	6	Bituminous	Local trade.
Davis mine, Danville seam	Danville	John E. Davis	2,000	6	do	Do.
Bensill mine, Danville seam.	do	Bolser Bensill	500	6	do	Danville.
Shock mine, Danville seam	Near Oakwood	Valentine Shock	400	5	do	Local trade.
Duncan mine, Danville seam.	Danville	Henry J. Duncan	400	5½	do	Do.
Hall mine, Danville seam	Catlin	Charles Hall	500	6	do	Do.
Veach mine, Danville seam	Near Oakwood	H. L. McConoughy	250	5⅜	do	Do.
Breen mine, Danville seam	Near Danville	James Breen	250	6	do	Do.
Ellsworth mine, Danville seam	Danville	Ellsworth C. Co	115,000	6	do	Wabash, Pac., and St. L. R. R.
Danville C. Co., Danville seam	do	Danville Coal Co	52,250	6	do	Ind., Bloomington, and west, Wabash, St. L. and Pac., and Danville and S. W. R. R.
Michael Kelly mine, Danville seam.	do	Michael Kelly	10,000	6	do	Danville and Danville Junc.
Kelly mine, Danville seam	do	William Kelly	5,000	6	do	Urbana and other towns west.
Dobbins mine, Danville seam	do	Charles J. Dobbins	5,000	6½	do	Local trade.
Danville seam	do	Alban J. Jenkins	3,000	6	Bituminous, soft	Towns along Wabash R. R.
John Thomas mine, Danville seam.	Oakwood	John Thomas	2,800	5⅜	Bituminous	Local trade.
Gones mine, Danville seam	Catlin	Underhill & Henderson	2,000	6	do	Do.
Inwood mine, Danville seam.	Blount	Samuel Swicher	2,500	5⅜	do	Country trade.
Thomas France mine, Danville seam.	Fairmount	Thomas C. France & Co	2,500	6	do	Fairmount and country trade.
Jordan mine, Danville seam	do	Alex. Morrison	2,000	5	do	Local trade.
Kirkland mine, Grape Creek seam.	Grape Creek	William Kirkland	2,000	6	do	Chi. and towns between mine and Danville.
Hodges mine, Danville seam.	Danville	Benjamin F. Hodges	1,300	6½	do	Local trade.
Daniel France mine, Danville mine.	Fairmount	Daniel France	1,500	6	do	Fairmount and country trade.
Holton mine, Danville seam	Danville	G. L. Holton	1,200	6½	do	Local trade.
Blakeney mine, Grape Creek seam.	Grape Creek	E. Blakeney	1,350	6	do	Danville.
McBrune mine, Danville seam	Near Oakwood	McBrune & Yerkes	1,300	6	do	Local trade.
South Town mine, Danville seam.	South Danville	John L. Fisher	1,900	6	do	Danville.
Elisha Loyd mine, Danville seam.	Near Oakwood	Elisha Loyd	1,200	6	do	Danville and neighboring towns.
Price's Strip Bank mine, Danville seam.	do	A. Thrush	1,000	6	do	Local trade.
Hasting's Bank mine, Danville seam.	North of Danville		1,000	6	do	Danville and country trade.
Brooks' mine, Grape Creek seam.	Grape Creek	Benjamin Brooks	800	6	do	Danville.
Wolf mine, Danville seam	Catlin	George Wolf	700	6	do	Catlin.
Davis mine, Danville seam	South Danville	William E. Davis	700	6	do	Danville.
Dower mine, Grape Creek seam.	Grape Creek	John Dower	600	6	do	Do.
Williams mine, Danville seam	Danville	Andrew Fredrickson	600	6	do	Local trade.
Thomas mine, Danville seam	Catlin	Thomas Thomas	850	5⅜	do	Do.
Laferty mine, Grape Creek seam.	Grape Creek	John Laferty	400	6	do	Danville.
	WARREN COUNTY.					
Millar mine, Big seam	3 miles south of Alexis.	W. L. Millar	1,000	3–4	Bituminous	Vicinity.
Brooks mine	Brooks	S. Cocken & Brooks	None.	2⅝	Bituminous, soft	
Simcock mine	Alexis	J. Simcock	1,600	2	do	Country trade.

Directory of bituminoas coal mines—Continued.

ILLINOIS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WARREN CO.—cont'd.			*Feet.*		
Barney Sloey mine, upper seam.	Greenbush township	Michael Murphy	200	2	Bituminous	Avon, Prairie City, and country.
L. S. Holden mine	Monmouth	L. S. Holden	2,800	2	Bituminous, soft	Local trade.
Compton mine	Near Avon	John B. Compton	600	1½	Bituminous, with but little sulphur.	Avon.
John Bell mine	Coldbrook	William Tporbes	827	2	Bituminous	Monmouth and surrounding country.
	4 miles S. of Kirkwood	Geor & Bryner	1,100	2	Bituminous, soft	Kirkwood and country trade.
Chicken mine	Warren	William Chicken	120		Bituminous	Monmouth and vicinity.
Uz, Winn mine	Monmouth township	Uz, Winn	760		Bituminous, soft	Monmouth.
	Youngstown	J. White	350	2	Bituminous	
	do	J. Willson	350	2	do	
	do	Willson & Maffin	360	2	do	
	Prairie City	Henry Murphy	400		do	
	Roseville	S. Waters	800	1⅔	do	
	do	Thomas Wamwuth	1,000	2	do	
	do	Alex Stanfield	300	2	do	
	do	Thomas Caldwell	300	2	do	
	Alexis	William Cook	300	4½	do	
	Spring Grove	do	800		do	Alexis, Illinois, and country.
	WASHINGTON COUNTY.					
Dubois mine, No. 5 seam	Dubois	David Thompson	4,000	5½	Bituminous, hard, fatty	Towns along Ill. Cen. R. R.
	WILL COUNTY.					
G. and H. shafts, Braidwood seam.	Braidwood	Chicago, Wilmington, and Vermillion Coal Company.	316,488	3	Bituminous, some pyrite	Chi., via C. and A. R. R.
Globe Eureka Nos. 1 and 2 mines.	do	Eureka Coal Company.	163,989	3½	Bituminous	Do.
Hunter mine	do	Hunter Bros	1,775	3	do	Local trade.
Star mine	do	Beard, Hickox & Co.	45,000	3	Bituminous, soft	Chi. and northwest.
Diamond mine	Wilmington	Wilmington C. Mining and Mfg. Co.	84,059		Bituminous	Chi., via R. R.
	WILLIAMSON COUNTY.					
Slope No. 1 mine, No. 7 seam	Carterville	Carbondale C. and Coke Co.	72,500	9	Bituminous, soft, fatty	St. Louis.
Dodd shaft, No. 7 seam	do	do	1,000	9	Bituminous	St. Louis and Cairo.
	WOODFORD COUNTY.					
Chi. and Minonk C. and Coke Co.'s mine, fourth seam.	Minonk	Miner T. Ames	101,060	3	Bituminous	Chi., nthn. Ill., Wis., Iowa, Dakota, Minn., and Ind.

INDIANA.

	CLAY COUNTY.					
Jackson mine, upper and lower seams.	Brazil	Jackson Coal Min. Co.	51,500	4	Bituminous, block	Indianapolis, Terre Haute, and Chi., via Vandalia R. R., Terre Haute R. R., C. and E. I. R. R., and L. N. A. and C. R. R.
Buckeye mine, upper seam	do	do	37,000	4	do	Do.
Morris mine	do	Brazil Block C. Co	35,321	3⅝	do	Milwaukee, Chi., Terre Haute, Indp., Battle Creek, Kalama., So. Bend, Mich. City, La Porte, and Stillwell, via C. and E. I. R. R., T. H. and I., I. P. and C., Mich. Cen., L. S., and M. S., Chi., and G'd Trunk.
Birch Creek mine	Jackson township	do	30,002	3¾	do	Do.
Furnace mine	do	do	33,390	3½	do	Do.
Brick Factory mine, upper seam.	Brick Factory	John Moody	482	3½	do	Terre Haute and Indp., via Vandalia R. R.
Old Clay mine, upper seam	do	do	800	4	do	Do.
Diamond mine	Wickland	B. Simpson	5,004	7	do	Indp. and Mattoon, via I. and St. L. R. R.
Bartlett mine	Brazil	W. W. Risher & Co	37,900	3-4½	Bituminous, block, very free from sulphur.	Chi., Indp., Terre Haute, and country, via T. H. and I., E. T. H. and C., and C. and E. S. R. R.
National mine	Newburg	H. Wheeler & Co	10,000	7	Bituminous	Indp., La Fayette, Terre Haute, St. Louis, via Vandalia R. R. and L. N. A. and C. R. R.
Liability mine, Block seam	Near Ashersville	Archibald Love	2,160	3½	Bituminous, block, very free from sulphur; furnace.	Brazil f'ce, Terre Haute and Indp., via Vandalia R. R.
Veach mine, lower seam	Van Buren township	R. R. Roberts	3,956	3½	Bituminous, block	Indp., Green Castle, Terre Haute, and Chi., via T. H. and I. R. R. and T. H. and D. I. R. R.

Directory of bituminous coal mines—Continued.

INDIANA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CLAY COUNTY—cont'd.			*Feet.*		
California mine	Brazil	Otter Creek Min. Co	12,329	3¾	Bituminous, block	Indp., Chi., Terre Haute, and St. L., via R. R.
Dalton mine, upper seam	Carbon	Richard James & Co	720	4	do	Indp., Terre Haute, Chi., and Paris, Ill., via I. and St. L. and I. and St. L. C. and E. I. R. R.
White Ash mine, upper and lower seams.	do	Coal Bluff Min. Co	21,520	7½	do	C., C., C. and Q. R. R., and I. and St. L. R. R., and Indianapolis and Terre Haute.
Dominion mine	Van Buren township	Bennett & Crawford	975	3½	do	Terre Haute.
Gartsherrie mine, upper and lower seams.	Brazil	Watson C. and Min. Co	49,601	7½	do	Chi., and Indp., via T. H. and I. R. R., and L. N. A. and C. and E. I. R. R.
Etna mine	do	do	33,204	4	do	Do.
Coal Brook No. 3 mine, upper and lower seams.	do	Brazil and Chi. C. Co	45,000	7½	do	Chi., Indp., and Terre Haute, via Vandalia, C. and E. I., L. N. A. and C. R. R.
Markland mine, K. or L. seam	Clay City	Trunkey & Pardee	5,660	3½	Bituminous, laminated, very free from pyrite.	Terre Haute, Indp., and Chi., via T. H. and S. E. R. R. and T. H. and Worthington R. R.
Keystone mine, upper seam	Brazil, S. Branch	Omsby Coal Co	21,704	3⅝	Bituminous, block	Chi., Indp., and Terre Haute, via C. and E. S. R. R., T. H. and I., L. N. A. and E., and M. C. R. R.
Brier Hill mine, first and second seams.	Harmony	Zeller & McClellan	90,000	8	do	Indp. and Terre Haute, via T. H. and I. R. R.
Erlich mine	Turner	P. Erlich & Co	58,147	7	Bituminous	Terre Haute, Indp., and La Fayette, via Vandalia line.
Horne mine	Staunton	Jos. Somers	2,540	6½	do	Terre Haute and Indp., via T. H. and I. R. R.
Buckeye shaft, upper seam	Brazil S. Branch	A. H. Woodruff & A. J. and J. H. Trunkey.	8,000	4	Bituminous, block, laminated	Chi., via C. and E. I. R. R., and L. N. A. and C., and M. C. R. R., and I. and E. H. R. R.
Diamond mine, first seam	Harmony	Stevens C. and Min. Co	18,866	4½	Bituminous, block	Indp., via T. H. and I. R. R.
Globe mine, second seam	Ashersville	do	15,200	3⅝	do	Line of S. N. A. and C. R. R. to Kalamazoo and Battle Creek, via T. H. and I. R. R.
Chicago mine, upper and lower seams.	Carbon	Brazil and Chi. C. Co	23,857	7⅝	do	Indp. and St. Louis, via I. and St. L. R. R.
Cornwell mine	Knightsville	William Watson	53,869	4	do	Chi., via C. and E. I. R. R., and Louisville, New Albany, and Chi. R. R.
Otter Creek mine	Otter Creek	do	35,000	4	do	Chi., via C. E. and I. R. R.
Eureka mine, upper and second seams.	Brazil	Andrew & Weaver	13,645	7¼	do	Terre Haute, Indp., and Chi., via Chi., Vandalia, and Ill.
David Moody mine, upper seam.	Cardonia	David Moody	1,800	4	do	Chicago.
Penn mine, first seam	Brazil	W. W. Risher	5,000	3½	do	Do.
Oak Hill mine	Oak Hill	H. W. Perry & Bro	1,200	3⅝	do	Indp. and Terre Haute.
Campbell mine, upper seam	Brick Factory	McGuire & Baylers	75	3½	do	Brazil.
Excelsior mine, top seam	Otter Creek	Nathan Hardman	3,000	3¾	do	Indp. and Terre Haute.
Centre Point mine, second seam.	Centre Point	O. T. Dunagan	3,000	3 11/12	do	Centre Point, Ashboro', Bowling Green, and central Clay county.
Happy Hollow mine, upper seam.	Staunton	Yocum & Little	400	7	Bituminous	Staunton, Indiana.
	Sugar Ridge township	George M. Moss	210	3	Bituminous, block	Bowling Green.
	do	Samuel D. Fortner	175	2¾	do	Do.
	Jackson township	William Butt	210	3½	do	Do.
	DAVIESS COUNTY.					
Maple Valley mine	Washington	Wilson, Kauffman & Co	4,854	4	Bituminous, soft	Line of O. and M. R. R.
S. Branch mine	do	Cabel, Wilson & Co	55,777	2½-5	do	Vincennes Olney, St. Lou's, Mitchell, Bedford, Seymour, and O. and M. R. R. Co., via O. and M. R. R.
No. 4 mine	do	do	8,080	3	do	Vincennes and St. Louis, via O. and M. R. R.
Sulphur Spring mine	do	do	71,663	2½-5	do	Mostly to O. and M. R. R. Co.
Cannelburgh mine, upper seam.	Cannelburgh	Buckeye Cannel C. Co	15,000	4	Bituminous and cannel	Chi., St. Louis, Vincennes, Indp., and New Albany, via O. and M., E. and T. H., I. and V., C. and E. I., L., N. A., and C. R. R.
Raglesville mine, upper seam	Raglesville	Albert Strickey	350	3	Bituminous, block	Clarksburgh and Raglesville.
Mattingly mine, upper seam	Joe Church Hill	Reister & Lockmiller	420	3	do	Washington.
E. H. Evans mine, upper seam	Raglesville	Critchlou & Ragle	70	3½	do	Raglesville and Clarksburgh.
E. H. Rayman mine	Washington	John & H. Rayman	420	2½	Bituminous	Custom trade.
Ætna mine, upper seam	Rhine	Martin & Seaford	420	2	do	Washington.
Concord mine, upper seam	Near Epsom	M. D. Payne	175	2¾	do	Surrounding country.
Eureka mine	Washington	Cabel, Wilson & Co	9,600	3	Bituminous, soft	Washington.
	Montgomery station	Rev. B. Pierce	140	3½	Bituminous	Neighborhood.
	Reeves township	Harroll & Ruggless	256	3½	Bituminous, block	Alfordsville, Indiana.

Directory of bituminous coal mines—Continued.

INDIANA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, add use when reported.	Markets and routes.
	DUBOIS COUNTY.			*Feet.*		
	Bainbridge township	Michael Rees	175		Bituminous	Jasper, Ind.
	do	Jos. Greft	52	3½	do	Do.
	Jackson township	Martin Hoffman	7	4	do	Huntingburgh.
	Jefferson township	Henry Schnell	70	2	Bituminous, block	Schnellville, Ind.
	Hall township	Henry Biershing	105	2½	do	Jasper, Ind.
	do	George Giel	35		do	Do.
	Boone township	J. A. Krodel	105	3	Bituminous	Portersville, Ind.
	do	Albert Gray	70		do	Do.
	FOUNTAIN COUNTY.					
Ogden & Bro.'s mine	Coal creek	Ogden & Bros	16,000	5	Bituminous, coking	Chi., via C. and E. I. R. R., via Danville.
Fountain Co. C. and Min. Co.	do	Fountain Co. C. and Min. Co.	105,300	5	do	Do.
Solliday & Moses mine, L. seam.	do	Solliday & Moses	3,200	5	Bituminous, coking, quite free from sulphur.	Nth. Chi. Rolling Mill, Chicago and Coal Cr., Ind.
Coal Creek mine, I. seam	Snoddy Mills	Trunkey & Pardee	72,118	5½	Bituminous, steam and domestic.	Chi. and country N. W. of Chi., via C. and E. I. R. R.
	GIBSON COUNTY.					
Stumpburg mine, upper seam.	Oakland City	Norman Taylor	600	2½	Bituminous	Oakland City and Princeton.
	GREENE COUNTY.					
	Richmond township	James Chaney	500	3	Bituminous	Mineral City, Ind.
	do	Andrew Burcham	210	2	do	Bloomfield, Ind.
	do	do	35	2	do	Do.
	do	do	175	2	do	Mineral City, Ind.
	Taylor township	Cyrus Isenogle	140	3	do	Bloomfield, Ind.
	Jackson township	Thomas D. George	140	2	Bituminous, block	Bedford, Ind.
	do	Nathaniel Smiley	630	2	do	Do.
	do	Charles Strosnidel	1,050	2	do	Do.
	Jackson township	Amos Porter	90	2⅝	Bituminous, block	Bedford, Ind.
	Stockton township	Rush Watson	280	4⅝	Bituminous, semi-block	Bloomfield, Ind.
	do	B. F. Watson	525	5	do	Neighborhood.
	do	J. E. Price	35	6⅜	do	Linton, Ind.
	do	Francis Lisman	140	6	do	Neighborhood.
	Grant township	James Landy	140	3	do	Bedford, Ind.
	Smith township	Theo. Jackson	175	2½	do	Worthington, Ind.
	Richland township	Jos. Rogers	70		do	Bloomfield, Ind.
	Wright township	Thos. M. Smith	20	7	Bituminous	Linton, Ind.
	do	David Bledsoe	500	6	do	Sullivan, Ind.
	do	John Harrel	70		do	Neighborhood.
	do	Robert Ellis	70	2	Bituminous, block	Do.
	Jefferson township	Eli Stalcup	400		Bituminous	Worthington, Ind.
	do	Emanuel Dixon	500		Bituminous, block	Do.
	do	Wm. E. Pugh	100		Bituminous, semi-block	Do.
	do	Geo. Heinemann	150		Bituminous, block	Do.
	Fairplay township	R. B. McKissick	1,134	2½	do	Do.
	Wright township	Jas. White	7	7	Bituminous	Neighborhood.
	KNOX COUNTY.					
Edwardsport mine, upper seam.	Edwardsport	Edwardsport C. Co	23,031	4⅛	Bituminous	J. M. and I. R. R., P. C. & St. L. R. R., and I. and V. R. R.
Do	do	do	25,000	4⅛	do	Do.
	do	Robert E. Dant	239	3½	Bituminous, soft, steam	Edwardsport, Ind.
	MARTIN COUNTY.					
Cross Roads mine	Shoals	Johnson & Chenoweth	200	3	Bituminous, block	Shoals, few cars shipped to station on O. and M. and other reads.
Love Bros. mine, upper seam	Loogootee	W. H. Love	1,200	2⅔	do	Loogootee.
	Baker township	Amos Porter	245	3	Bituminous	Bedford Ind.
	Columbia township	Philip Gammon	77	3⅝	do	Shoals, Ind.
	do	Nelson Cook	35	3½	do	Do.
Patterson	Loogootee	Wm. P. Patterson	100	4	do	Loogootee.
	OWEN COUNTY.					
	Marion township	John Furry	200	4	Bituminous, block	Terre Haute, Ind.
	do	John Schmalz	105	4	do	Spencer, Ind.
	do	Wm. Folliver	35	2	do	Bank, Ind.
	do	L. D. Cotts	315	4	do	Lancaster, Ind.
	do	Stephen Maegerlein	280	4	do	Neighborhood.

Directory of bituminous coal mines—Continued.

INDIANA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported	Markets and routes.
	OWEN CO.—continued.			Feet.		
.....	Marion township	John C. Stahl	270	4½	Bituminous, block	Marion Hill, Ind.
.....	Jefferson township	Pryer & Clemitt	45	3 1/12	do	Terre Haute, Ind.
.....	La Fayette township	Winfield Norman	210	3	do	Spencer, Ind.
.....	do	David Wagoner	105	5	do	Do.
.....	Jefferson township	Solomon Armey	350	3½	Bituminous	Neighborhood.
.....	do	Jesse Reagan	42	3⅝	Bituminous, block	Do.
.....	do	Josiah Hochstetler	210	3½	do	Worthington, Ind.
.....	do	John G. Smith	7	3½	do	Do.
.....	do	do	18	3½	do	Do.
.....	do	Jos. Needy	18	3	Bituminous	School-houses.
.....	Marion township	John Row	600	4	Bituminous, block	Bowling Green.
.....	do	Wolf & Gonser	35	3	do	Clay City, Ind.
.....	do	E. H. Morris	350	5	do	Do.
.....	do	Jacob Naalebarger	35	4	do	Do.
.....	Jefferson township	Geo. Haviland	18	3	do	Neighborhood.
	PARKE COUNTY.					
Thistle mine, L seam	Rosedale	Barnett Lewis	3,000	5½	Bituminous	Frankfort, La Fayette, and Logansport, via Terre Haute and Logansport R. R.
French Coal Co.'s mine, K seam.	Nyesville	Louis N. Grinlee	18,912	4	Bituminous, dry, very bright	T. H. and L. R. R., Rockville, Waveland, Crawfordsville, La Fayette, Colfax, Frankfort, and Logansport, via T. H. and L., C. I. and St. L., and C., and F., and K. R. R.
Mammoth mine, L seam	Rosedale	Jos. Martin	8,348	5	Bituminous	Logansport, La Fayette, and intervening points, via T. H. and L. R. R.
Sand Creek No. 1 mine	Nyesville	Sand Creek Coal Company.	17,265	4	Bituminous, semi-block	Crawfordsville, La Fayette and Ind'p and L. C. and S. W. R. R. Co., via L., C. and S. W. R. R., L., N., A. and C. R. R., I., B. and W. R. R., C., I., St. L. and C. R. R.
Parke County Coal Co.'s mine	Clinton Leck	Alexander & Cannon	9,860	5	Bituminous	Chicago and Indianapolis.
Barnett Morey mine, Mammoth seam.	do	F. A. Bowen	13,308	5	Bitumidous, semi-block	Chi. and points along C. and E. I., I., D. and S., and W., St. L. and P. R. R.
	PERRY COUNTY.					
Cannelton mine	Cannelton	Amer. Cannel C. Co	7,740	2½	Bituminous	Steamboats on Ohio river and tributaries.
McMahon mine	do	Patrick McMahon	260	2½	Bituminous, block	Cannelton.
Clark mine	do	James Clark	1,393	3½	do	Do.
	PIKE COUNTY.					
Smith mine	Petersburg	E. F. Smith	700	9	Bituminous	Petersburgh.
W. H. Posey mine, K seam	do	W. H. Posey	1,225	7½	do	Petersburgh and White and Wabash rivers.
Posey mine	do	J. B. Borer	1,750	7	do	Petersburgh and vicinity.
.....	Patoka township	Ingle & Co	6,000	.....	Bituminous, block	Indiana.
Martin mine	Near Oakland City	Jos. D. Bacon	250	6	Bituminous, semi-block	Oakland City, Ind.
.....	Marion township	C. G. Beach	100	5	Bituminous	Neighborhood.
.....	Jefferson township	George Matue	175	4½	do	Do.
.....	Patoka township	J. P. Harris	175	5½	do	Oakland City, Ind.
.....	do	C. B. Wilder	21	.....	do	Augusta. Ind.
.....	do	Edw. Heacock	120	5	do	Winslow, Ind.
.....	do	William H. Moulton	105	.....	do	Do.
.....	Monroe township	R. C. Hamilton	70	5⅚	do	Pleasantville, Ind.
.....	do	Harvey Hart	100	.....	do	School-houses.
.....	Lockhart township	Justice Miller	70	2½	do	Neighborhood.
.....	Washington township	Jos. Hays	500	8	do	Petersburgh, Ind.
.....	do	William Dennis	12	.....	do	Do.
.....	Logan township	Martin Falls	53	3	do	Union, Ind.
.....	do	D. A. Miller	70	3	do	Do.
.....	Lockhart township	Nathaniel Wilder	35	4½	do	Augusta, Ind.
.....	do	Alexander Sloan	150	5	do	Do.
.....	do	Hinkle, Face & Co	700	5	do	Do.
.....	do	Thomas Scales	35	4	do	Do.
.....	do	John Helman	20	3½	do	Pikeville, Ind.
.....	do	D. & L. R. Broadwell	35	1½	do	Do.
.....	Jefferson township	George Mackaway	300	.....	do	Pike county.
	SPENCER COUNTY.					
Medcalf mine	Dale	Gabriel Medcalf	245	2½	Bituminous	Dale and Rockport.
Smith & Fisher mine	Grass township	Louis G. Smith and Robert Fisher.	2,651	4	Bituminous, semi-block	Rockport.

Directory of bituminous coal mines—Continued.

INDIANA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SPENCER CO.—cont'd.			*Feet.*		
Hopkins mine, No. 11 seam	Near Newtonville	Hugh McCall	1,786	4	Bituminous, semi-block	Grandview, Newtonville, and Rockport.
Barker mine	Buffaloville	William G. Barker	637	3⅜	Bituminous, medium	Rockport and Jasper.
Farrow mine	Dale	James Farrow	840	2½	Bituminous, resembling block.	Dale and Rockport.
Staub mine	Near Mary Hill	Henry Lear	357	3	Bituminous, block	Rockport and surrounding country.
	Harrison township	Jos. Schum	25	3½	Bituminous	Ferdinand, Ind.
	SULLIVAN COUNTY.					
Shelburn mine, upper seam	Shelburn	Shelburn C. Co	14,049	4	Bituminous	E. & T. H. R. R. Co., Terre Haute, Hartford, Carlisle, and Oaktown, via E. and T. H. R. R.
Sullivan mine, upper and lower seams.	Sullivan	do	4,751	7½	do	Do.
McAnally mine, lower seam	Shelburn	McAnally & Son	3,300	5	do	Terre Haute, Paris, and Carlisle, via E. & T. H. R. R. and L. & S. T. L. R. R.
Pittsburgh mine, second seam	Hymera	Stock & Coffee	3,000	6	do	Sullivan, Carlisle, Oaktown, Vincennes, Hazleton, Princeton, via E. and T. H. R. R.
Pittsburgh mine, middle seam	Pittsburgh	Henry Snowden	750	5½	do	Terre Haute, Shelburn, and Oaktown.
	Curry township	Froment & Atkinson	700		do	Terre Haute, Ind.
	Cass township	Hancock & Co	100		do	Sullivan, Ind.
	do	R. M. Kirkham	280	7	do	Do.
	do	Henry Wilson	20	6	do	Bank.
	Near Ascension	Edwin Baskeen	130		do	Neighborhood.
	do	William C. Carpenter	53		do	Do.
	Near Ascension	Wm. Bennett	350		Bituminous	Neighborhood.
	do	Noah Crawford	175		do	Do.
	do	Asa Mahan	150		do	Do.
	Jackson township	Geo. W. Ford	63		do	Do.
	do	Green Shepherd	7		do	Do.
	Jefferson township	Ohaver, Hunter & Co	400	4½	do	Do.
	Near Ascension	David Sharp	700		do	Do.
	Cass township	W. H. Sexton	100		do	Do.
	VANDERBURGH COUNTY.					
First Avenue mine, M seam	Evansville	Thomas Sons	9,510	4½	Bituminous, coking, gray or red ash.	Evansville.
Ingleside mine	do	John Ingle & Co	31,097	4	Bituminous	Evansville City, steamboats and points within 40 miles, via S. E. R. R. and Ohio river.
	VERMILLION COUNTY.					
Brier Hill mine, L seam	Clinton	Merrill & Co	5,000	4⅚-6	Bituminous	Terre Haute, Tuscola, Indp. and Chi., via C. and E. I. R. R. and I. D. and S. R. R.
Hazel Bluff mine, L seam	Clinton township	Brown & Henshaw	4,725	5	Bituminous, coking	Chi. and Indp., Tuscola and intervening R. R. points.
	VIGO COUNTY.					
North Switch mine, upper seam.	Coal Bluff	J. S. King & Co	3,348	6½	Bituminous	Coal Bluff Mining Co.
Webster mine, second seam	do	Coal Bluff Min. Co	25,000	6	do	Terre Haute, Indp. and I. and St. L. R. R.
Somerset mine, upper seam	Lockport	Wm. A. Connely	3,130	4⅚	do	Terre Haute and Paris, via C. and T. H. and Ill. Midland.
Bright Fire mine, lower seam	Sugar Creek	W. H. Dehisle	220	5⅝	Bituminous, fat, coking, long flame.	Terre Haute and local market.
Sugar Creek mine	Maxville	Jos. Broadherst	162	4½	Bituminous	Neighborhood and Terre Haute.
Leck mine, upper seam	Fayette township	G. W. Leek	525	4¾	do	Sanford and Terre Haute.
	do	Joshua Martin	6	4⅚	do	Neighborhood.
	do	Geo. Houser	87	4⅜	do	Sanford, Ind.
	do	Fred. Miller	35	4⅜	do	Goshen, Ind.
	do	P. W. Halloran	125	5	Bituminous, semi-block	Terre Haute, Ind.
	Sugar Creek township	Jas. Lunday	280	5½	Bituminous	St. Mary's, Ind.
	do	Philip Eckis	700	5½	do	Terre Haute, Ind.
	Near Pimento	Elizabeth Ray	200		do	Neighborhood.
	WARREN COUNTY.					
Fink mine, upper seam	Fall Creek	Andrew Fink	20	3⅝	Bituminous, block	Do.
Claypool mine, upper seam	Coal Branch	David Wells	500	3⅝	Bituminous, semi-block	Mines and Covington.
Thomas mine, second seam	Carbondale	John R. Jones	350	2¾	Bituminous, block	Neighborhood.
Hunter mine	do	R. St. C. Hunter	210	3½	Bituminous, semi-block	Do.
Luppold mine, upper seam	Fall Creek	Mathias Luppold	500	3⅝	Bituminous, block	Do.
Jarvis mine, upper seam	do	A. C. Jarvis	175	3	do	Williamsport and Attica.
Long mine, second seam	Coal Run	George Morlan	210	2½	do	Bank.
Cronkhite mine, upper seam	Coal Hollow	A. B. Cronkhite	525	3	do	Mine.

Directory of bituminous coal mines—Continued.

INDIANA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WARRICK COUNTY.			*Feet.*		
De Forest mine	Boone township	B. Menden	6,530	4–6	Bituminous	Evansville, via S. E. and I. W. R. R.
Henderson mine, M seam	do	David Henderson	1,666	4½	Bituminous, semi-block, with pyrite and calcite.	Evansville, via Evansville and Eastern R. R.
Chandler mine, No. 9 seam	Chandler station	Musbet, Hall & Co	4,571	4	Bituminous	Do.
Locust Grove mine, No. 9 seam	Newburgh	Albert Hazen	8,836	3⅝	Bituminous, heavy	Evansville, Newburgh, and steamboats at mine, via Ohio river.
Newburgh mine, I seam	do	J. & D. Love	11,571	3⅝	Bituminous, rich	Steamboats at mine.
Excelsior mine	Boone township	William H. Stone	590	5	Bituminous, clean, dry, coking.	Boonville, Evansville, and Mount Vernon.
Gough mine	Boonville	Robert Gough	525	6	Bituminous, bright, quite free from pyrite.	Boonville and Evansville, via R. R.
Boonville Coal Co., upper seam.	do	Elk Horn Mill Co	1,885	4	Bituminous, coking, quite free from pyrite, steam.	Boonville.

IOWA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ADAMS COUNTY.					
Bell mine	Carbon	Alex. Bell	2,400	1½	Bituminous	Carbon and Corning.
Rimbey mine	do	L. D. Rimby	500	1⅔	do	Do.
Gabbie mine	do	Thomas Gabbie	1,200	1½	do	Do.
Stephany mine	do	John Stephany	385	1½	do	Do.
Pickard & Hill mine	do	Pickard & Hill	802	1½	do	Do.
Combs mine	do	Albert Combs	1,450	1½	do	Do.
Bittern mine	Two miles west of Carbon.	John G. Bittern	300	1½	do	Do.
Neill mine	Two miles southwest of Carbon.	Jos. Hartshorn	700	1½	do	Local trade.
Hudspath & Hugh's mine	Ten miles north of Carbon.	Hudspath & Hughs	450	1⅛	do	Do.
	APPANOOSE COUNTY.					
Watson C. and Min. Co	Centerville	Watson C. and Min. Co.	14,500	3½	Bituminous, soft	Local trade.
Hubbard mine	Hilltown	John Hubbard	1,200	3	Bituminous	Do.
Schwartz mine	do	Wesley Schwartz	1,000	3	do	Do.
Kendig mine	Centerville	Benjamin Kendig	1,400	3	do	Do.
Brazil mine	do	J. A. Brazil	2,500	3	do	Local trade and as far as Keokuk.
Dickey mine	do	W. H. Dickey	3,000	3	do	Local trade.
Christian mine	do	Oliver & Dargnalt	3,100	3	do	Muscatine, Leavenworth, and Cameron.
McClarg mine	do	Thomas McClarg	1,200	3	do	Local trade.
Appanoose C. Co.'s mine	do	Appanoose Coal Co	13,200	2⅜	do	N. E. to Iowa City, W. to Van Wist, Iowa.
Gwinn	Hilltown	R. D. Gwin	1,500	3	do	Local trade.
Centerville C. Co.'s mine	Centerville	Centerville Coal Co	4,900	3	do	Local trade and Keokuk.
Miller & Houston mine	Numa	Miller & Houston	2,700	2⅜	do	Leavenworth and local trade.
Blackburn mine	do	Jos. Blackburn	1,300	2⅜	do	Do.
Caldwell mine	Caldwell	Iowa and Missouri C. and Land Co.	6,100	2½	do	North to Shell Rock, E. to Burlington and local trade.
	Dennis	Jos. Artist	1,500		do	
	BOONE COUNTY.					
Lower View Coal Co.'s mine, upper and lower seams.	Boonesborough	Lower View Coal Co	25,000	7½	do	
Logan & Camfield mine, upper and lower seams.	do	Logan & Camfield	15,000	7½	do	East to Cedar Rapids and west to Nebraska.
Boone & Marshall mine, lower seam.	do	Boone & Marshall	6,000	3½	do	Chicago and N. W. R. R.
N. W. Coal Co.'s mine	Coal Valley	N. W. Coal Co	6,000	3	do	Do.
Moingona Coal Co.'s mine, middle seam.	Moingona	Moingona Coal Co	12,000	1⅜–3	do	C. and N. W. R. R. as far west as Council Bluffs.
Boone Lower Vein C. Co.'s mine.	Coaltown	J. F. Duncombe	45,000	4½	do	Iowa R. R. Co. and private parties.
Rogers & Crow mine, upper and lower seams.	Boonesborough	Rogers & Crow	6,000	6½	do	C. and N. W. R. R. as far east as Cedar Rapids.
Hutchinson & Bro.'s mine	Zenorsville	Hutchinson & Bro	10,000	3⅜	do	N. to Callanan, east to Blairstown.
Clemmens mine	do	J. Clemmens	9,500	3⅜	do	North to Callanan.
York mine	do	Jos. York	2,000	3	do	Local trade.
	DALLAS COUNTY.					
Van Meter mine	Van Meter	Chi. and Van Meter Coal Company.	15,000	7	Bituminous	Local and Rock Island R. R.

Directory of bituminous coal mines—Continued.

IOWA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	DAVIS COUNTY.			*Feet.*		
Dye mine	3 miles SW. of Eldon	Eli Dye	500	4½	Bituminous	
Dunn mine	2 miles east of Carbon Station.	George W. Dunn	5,000	4⅝	Bituminous, locomotives	Wabash, St. L. and Pac. R. R.
	GREENE COUNTY.					
Keystone mine, lower seam	Rippey	Stout, Markham & Jones.	3,550	4½	Bituminous	
Armstrong mine, lower seam	do	Armstrong Brothers	2,000	4	do	C. and N. W. R. R. and branches.
Green County Coal Co.'s mine	do	J. F. Duncomb	3,000	4⅜	do	Iowa, Minnesota, and Nebraska.
	HAMILTON COUNTY.					
	Homer	Cuff & O'Connell	3,000		Bituminous	
	HARDIN COUNTY.					
Chaffin mine	Eldora	M. A. Chaffin	2,000	3⅝	Bituminous	Eldora and local trade.
Woodhead mine	3 miles N. of Eldora	Charles Woodhead	208	2½	do	Local trade.
Madden mine	2½ miles N. of Eldora	John F. Madden	252	2½	do	Do.
Shaver & Wood mine	do	Shaver & Wood	675	3½	do	Do.
	JASPER COUNTY.					
Adamson Grove mine	Adamson Grove	Kay & Drew	500	3	Bituminous	Do.
Riley mine	4 miles S. of Newton	John Riley	300	4	do	Newton.
Bieley mine	Powesheik township	Gedo Bieley	4,150	4½	do	Local trade.
McIlhone mine	3 miles S. of Newton	J. McIlhone	500	4	do	Newton.
Bear Grove mine	Mount Paine township	John Hanna	600	3	do	Local trade.
Black Oak Grove mine	3 miles northwest of Lynnville.	Jas. Rusher	1,800	1⅝	do	Do.
Davidson mine	3 miles S. of Newton	Robert Davidson	3,000	5	do	
McAllister mine	do	Stewart & Brown	1,050	4	do	Newton.
Stewart & Brown mine	do	do	135	4	do	Do.
Snooks mine	do	Snooks Brothers	7,500	4	do	Do.
Lister mine	2 miles S. of Newton	William Lister	5,040	4	do	Do.
Johnson & Braden mine	Powesheik township	Johnson & Braden	1,200	5	Bituminous	Local trade.
Blackheath mine	do	Fish & Pease	2,500	5⅝	do	Do.
Adsit & Fitzhugh mine	3 miles northwest of Collax.	Adsit & Fitzhugh	3,355	5⅝	do	Do.
Meredith mine	3 miles northwest of Lynnville.	Thomas Thompson	700	1⅝	do	Do.
Slaughter mine	Sherman township	Scott Slaughter	4,120	5	do	Do.
Jasper County C. R. R. Company's mine.	4½ miles south of Newton.	Jasper County C. R. R. Co.	29,500	5	do	Newton, Chi., R. I. and Pac. R. R.
Buckley mine	3 miles east of Monroe.	R. S. Buckley	1,800	4	do	
Edwards mine	do	Elias E. Edwards	1,080	4½	do	Local trade.
Blount mine	do	George Blount	1,600	3½	do	Do.
Morris mine	Des Moines township	James D. Morris	4,032	4	do	Do.
	JEFFERSON COUNTY.					
McLain mine	2 miles west of Fairfield	Russell, Crew & Co	700	2	Bituminous	Fairfield.
Jefferson County Coal Company's mine.	Perlee	Jefferson County Coal Co.	12,000	3⅝	do	As far north and west as Cedar Rapids also C., R. I. and P. R. R.
Washington mine	do	Washington Coal Co	19,500	3½	do	C., R. I. and P. R. R. Co.
Coalport mine	Coalport	Brown Bros	4,200	3½	do	Mount Pleasant.
Ratcliff mine	2 miles southwest of Fairfield.	R. F. Ratcliff	350	3	do	Local trade.
Cedar mine	4½ miles south of Fairfield.	James Irvine	4,000	3⅜	do	Do.
Larimore mine	5 miles southwest of Fairfield.	J. W. Larimore	500	2½	do	Do.
Finney mine	2 miles northeast of Eldon.	John Finney	1,000	3½	do	Do.
Sullivan mine	5 miles southwest of Fairfield.	William Sullivan	700	2½	do	Do.
Bishop mine	8 miles southwest of Fairfield.	John Bishop	600	2½	do	Do.
Rodabaugh mine	do	Joseph Rodabaugh	600	3	do	Do.
Overturf mine	10 miles southwest of Fairfield.	George Overturf	2,000	3½	do	Do.
	KEOKUK COUNTY.					
Star mine	What Cheer	Star Coal Co	15,000	6	Bituminous, soft, dry-burning, free from sulphur; steam.	Line of B., C. R. and N. R. R. and Minn.
Club mine	do	William Club	4,900	6	Bituminous	Local trade, and as far north as Minn.
Delta mine	2½ miles south of Delta.	Dunn Bros	5,000	5	do	Local trade.

Directory of bituminous coal mines—Continued.

IOWA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	KEOKUK CO.—cont'd.			*Feet.*		
Black Diamond mine	3 miles south of Delta.	J. M. Olive	6,000	4½	Bituminous	Local trade.
Durlane mine	2½ miles north of Sigourney.	E. F. Durlane	3,300	5	do	Sigourney and local trade.
Snyder mine	3½ miles east of What Cheer.	Snyder Bros	1,500	5	do	Local trade.
Elliot mine	3 miles southeast of What Cheer.	George Elliot	750	5	do	Do.
Lund & Ferguson's mine	What Cheer	Fox, Lund & Ferguson	3,900	7	do	What Cheer.
France, Rhodes & Bedford mine.	One-half mile northeast of What Cheer.	France, Rhodes & Bedford.	2,500	6½	Bituminous, white ash	Local trade.
Emmons mine	3 miles northwest of What Cheer.	Albert Emmons	2,100	6	Bituminous	Do.
Rincheart mine	3 miles west of Springfield.	George Rincheart	1,900	5	do	
Rowley mine	1½ miles northeast of What Cheer.	Samuel Rowley	2,000	6	do	Local trade.
	LEE COUNTY.					
	Hillsborough	Tim. Rice	500	3½	Bituminous	Do.
	LUCAS COUNTY.					
White Brush mine	Cleveland	White Brush Coal and Mining Co.	125,353	5½	Bituminous	West to Kearney, Nebr., and towns on C., B. and Q. R. R. and west of Chariton, Iowa.
Bingham mine	3 miles north of Chariton.	John Bingham	300	1½	do	Chariton.
Richmond mine	4 miles north of Chariton.	Bryan Richmond	200	1½	do	Do.
McVeighs mine	do	Charles McVeighs	160	1½	do	Do.
Farmers' Coal Co.'s mine	Russell	Farmers' Coal Co	None.	3½	do	
	MAHASKA COUNTY.					
Excelsior Coal Co.'s mine, second seam.	Oskaloosa	Excelsior Coal Co	70,000	5⅝	Bituminous	Northern Iowa, Minn., and Dakota via Cen. Iowa R. R. and connecting roads.
Consolidated Coal Co.'s 1, 2, and 3 mine.	Muchachinock	Consolidated Coal Co	109,205	6½	do	R. R. of Iowa and Minn. as far north as St. Paul, west as Omaha, east as Miss. river.
Iowa Coal Co.'s mine, Oskaloosa seam.	Beacon	C. L. Williams	29,103	6½	Bituminous, hard, small amount of sulphur.	Des Moines, Council Bluffs, Omaha, and Keokuk.
No. 5 mine	do	Consolidated Coal Co	28,000	8	Bituminous	Rock Island R. R.
Williams mine	Givin	Evan Williams	700	4	do	Givin and K. and D. V. R. R.
Moody mine	Knoxville Junction	J. W. Moody	500	5½	do	West on R. I. R. M. as far as Council Bluffs.
J. W. Walton mine	Leighton	J. W. Walton & Co	4,000	4½	do	Des Moines and local trade.
Shoemaker mine	do	Shoemaker & Son	3,700	4½	do	Local trade.
Ellis mine	Spring creek	Lindsay Ellis	1,000	6	do	Country trade.
Barroman mine	do	William Barroman	1,150	5½	do	Local trade.
Smith mine	3 miles northeast of New Sharon.	Hugh Smith	2,625	4	do	Do.
Robert Evans mine	do	Robert Evans	3,900	4½	do	
Heintzman mine	3½ miles northeast of New Sharon.	J. B. Heintzman	2,500	4	do	New Sharon and local farm trade.
Evans mine	4 miles northeast of New Sharon.	William E. Evans	2,300	4	do	Do.
Thompson mine	North of Eddyville	L. R. Thompson	400	4½	do	Local trade.
Roberts mine	Oskaloosa	J. F. Roberts	1,744	4½	do	Oskaloosa.
Ogden mine	do	John Ogden	1,800	4½	do	Do.
Guthrie mine	do	J. D. Guthrie	1,200	5½	do	Do.
Smith mine	do	Smith & Fewall	2,320	4½	do	Do.
Horahan mine	do	W. F. Horahan	2,425	6	do	Do.
Oskaloosa mine	do	John Ream & Son	3,594	5	do	Do.
Pickens mine	3 miles north of Eddyville.	Matthew Pickens	800	3½	do	Local farm trade.
Oskaloosa mine	Oskaloosa	John Burdese	8,000	5	do	Line of C., R. I. and P. R. R.
Hardin mine	North of Eddyville	Lewis Hardin	720	5	do	Local trade.
Oldham mine	3 miles north of Eddyville.	Aaron Oldham	400	4½	do	
Minnick mine	Oskaloosa	William Minnick	1,000	3½-6	do	Oskaloosa.
Long mine	do	John Long & Son	750	5½	do	
	MARION COUNTY.					
Knoxville Nos. 2 and 3 mines.	Knoxville	J. T. James & Co	10,278	4	do	Knoxville and west as far as Nebraska.
Oak Hill mine	Flagler's	George I. Butler & Co	9,472	6	do	Southwestern Iowa and Nebraska.
Knoxville City mine	Knoxville	W. A. Gamble	3,200	4	do	Local.

Directory of bituminous coal mines—Continued.

IOWA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MARION CO.—cont'd.			*Feet.*		
Ruckman mine	3 miles southeast of Knoxville.	S. M. Ruckman	1,500	3⅚	Bituminous	Knoxville.
Robinson mine	do	Lewis Beidle	512	4	do	Local trade.
S. W. Harvey mine	Knoxville	S. W. Harvey	200	3½	do	Do.
Thompson mine	Pella	William Thompson	1,300	4½	do	Pella.
Hamilton mine	2 miles northwest of Hamilton.	George W. Williams	1,600	4½	do	Via C., B. and Q. R. R. to Albion, and local trade.
Dewrose mine	Otley	W. Dewrose	500	4	do	Local trade.
Warner mine	do	L. H. Warner	600	4	do	
Marshall mine	Red Rock	Geo. Marshall	2,000	3½	do	Do.
Kinart mine	do	Sam'l Kinart	400	3½	do	Do.
Sherman mine	1½ mile NE. of Dallas	J. Duncan	600	3	do	Do.
Fortune mine	2 miles NE. of Dallas	Peter Fortune	400	4	do	Do.
Knox & Co.'s mine	3 miles SW. of Pleasantville.	Knox & Co	1,000	4	do	Do.
South Cedar mine	Marysville	R. H. Lever	3,895	5	do	Albion and Whitebreast Coal Co., and local trade.
Leibig mine	do	Wm. Tally	400	4½	do	
Flagler's mine	Flagler's	Union C. and Min. Co	30,000	6	do	Iowa and Nebraska.
	MONROE COUNTY.					
Avery Coal and Mining Co	Avery	Watson & Hammond	24,000		Bituminous, soft	East to Mount Pleasant, west to Kearney, Nebr.
Hickory Grove mine, 3d seam	Hickory Grove	Hickory Grove C. Co	20,000	5	Bituminous	North to Mason City, Iowa, and intermediate points on Iowa Central R. R.
Western Coal Co.'s mine	Frederic	Akers & Jamison	3,000	4	do	Creston, Council Bluffs, Lincoln, Nebr., and other places west.
Albia Coal Co.'s mine	3 miles W. of Albia	Albia Coal Co	84,788	5½	do	South to Burlington, west to Kearney junction.
Eureka mine	Frederic	Eureka Coal Co	12,000	3⅜	Bituminous, very hard, clean, bright.	Kearney, Nebraska, and east to Moun Pleasant.
Frederic mine	do	Frederic Coal Co	12,000	3⅜	Bituminous	As far west as Nebraska.
Coalfield No. 3 mine	Coalfield	Consolidated C. Co	18,000	5	do	Northern Iowa and southern Minnesota, via I. C. R. R.
Cedar mine	3 miles W. of Albia	Jno. Hartsuck	3,000	4	do	
Moss mine	2 miles N. of Frederic	John Moss	1,500	4½	do	Local trade and Fredericksburg.
Byer mine	Avery	E. W. Byer	3,000	5	do	Local trade and west to Hastings, Nebr.
	PAGE COUNTY.					
Pinkerton mine	5 miles SW. of Clarinda	Sam'l Pinkerton	1,300	1½	do	Local trade.
Aiken mine	4 miles SE. of Clarinda	Wm. Aiken	900	1¼	do	Do.
Prosser mine	2 miles SE. of Clarinda	Thos. Prosser	3,000	1⅞	do	Clarinda and local trade.
	POLK COUNTY.					
Watson Coal and Mining Co., second seam.	Des Moines	Watson C. and Min. Co.	28,412	4½	do	Local trade.
Sebastopol C. Co.'s mine, second seam.	Sebastopol	John Weber	3,200	4⅜	Bituminous, soft	Local trade at Des Moines.
Eureka mine, second seam	Des Moines	Eureka C. and Min. Co.	14,000	4	Bituminous	Line of C., R. I. and P. R. R. Co. west of Des Moines to Council Bluffs.
Eclipse mine, second and third seams.		Eclipse C. and Min. Co.	21,500	8	do	Line of R. I. and P. R. R. from Des Moines to Council Bluffs.
South Park mine, third seam	Des Moines	Pioneer Coal Co	45,000	5	Bituminous, soft	
Union mine, second seam	Sebastopol	Caleb Johns	2,800	4	do	Des Moines.
Pleasant Hill mine, second seam.	Des Moines	Pleasant Hill C. Co	5,000	4½	do	Do.
Polk Co. mine, second seam	do	Polk Co. C. Co	8,000	4½	do	Des Moines and local trade.
Enterprise mine, first seam	E. Des Moines	C. J. & A. W. Carlson	150	3	do	Des Moines.
	Vandalia	Mrs. McKinney	1,000		Bituminous	
	SCOTT COUNTY.					
Iowa mine	2 ms. N. of Buffalo	Felix Mackin	3,000	2⅚	Bituminous	Local trade.
Morris mine	4 ms. NE. of Buffalo	John Morris	1,400	2⅚	do	Buffalo and Davenport.
Murray mine	3½ ms. NE. of Buffalo	John Murray	1,100	2⅚	do	Do.
Williams mine	8½ ms. W. of Davenport	Robert Williams	1,000	2⅚	do	Davenport and local trade.
James mine	8 ms. W. of Davenport	James & Dodge	8,000	3	do	Do.
	TAYLOR COUNTY.					
Bomar mine	Nodaway township	F. J. Bomar	400	1½	Bituminous	Local trade.
Patch mine	do	Smith Patch	1,000	1½	do	Do.
Wilcox mine	do	Nathan Wilcox	1,000	1½	do	Do.
	VAN BUREN COUNTY.					
Business Corner mine		Alexander Finley	4,800	3⅜	Bituminous	R. R. and local trade.
Plymouth Hill mine	Farmington	Charles H. Scott	3,600	5½	Bituminous, steam	Line of B. and S. W. R. R.
Boyer's mine	Boyer's station	Iowa and Mo. C. and Land Co.	5,400	5	Bituminous	East to Burlington.

Directory of bituminous coal mines—Continued.

IOWA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WAPELLO COUNTY.			*Feet.*		
Southwestern mine, Nos. 1 and 3 seams.	Laddsdale	S. W. C. and Min. Co.	8,200	8	Bituminous, soft, free from minerals, except blackjack.	R. R. and local trade on C., R. I. and P. R. R.
Brown mine	3 ms. S. of Kirkville	Alex. Brown	1,700	5	Bituminous	Local trade. Ottumwa.
Dotts mine	Eddyville	Philip Dotts	990	4	do	Country trade.
Clark mine	5 m. W. of Eddyville	Hugh Clark	700	4	do	Farmers' trade.
Ennis mine	5 m. SE. of Ottumwa	John McColligan	200	4	do	Ottumwa.
No. 1 mine	3 miles N. of Ottumwa	W. G. Bowes	150	4	do	Do.
Briscoe mine	3 miles S. of Ottumwa	John O. Briscoe	125	2 11/12	do	Do.
	Laddsville	Benjamin W. Ladd	8,000		do	
Wood mine	Kirkville	M. E. S. Rouble	1,350	5	do	Kirkville.
Marshall mine	do	Joshua Marshall	1,600	5	do	Country trade.
J. L. McLaughlin mine	do	J. L. McLaughlin	460	4	do	Ottumwa.
Fix & Postlewaite mine	5 miles W. of Ottumwa	Fix & Postlewaite	30,000	5	do	Ottumwa and C., B. and Q. R. R. as far east as Burlington.
Sheppard mine	3½ m. NW. of Ottumwa	William Sheppard	5,800	4	do	Ottumwa.
Goodwin mine	3 miles N. of Ottumwa	Samuel Goodwin	600	4	do	Do.
Dickson mine	Ottumwa	A. & William Dixon	2,900	4	do	Do.
Barton mine	5 miles S. of Ottumwa	William Barton	1,200	3½	do	Do.
Graves mine	3 miles N. of Ottumwa	A. L. Graves	2,000	4	do	Do
Brownfield and two others mine.	5 m. SW. of Ottumwa	Brownfield and others.	1,500	3	do	Ottumwa and local country trade.
	WARREN COUNTY.					
Starbuck mine	Lacona	J. Starbuck	300	1¼	Bituminous	Local trade.
Johnson mine	do	John Johnson	300	1¼	do	Do.
Randolph mine	5 ms. SW. of Indianola	John Randolph	860	4½	do	Do.
Lord mine	2 miles E. of Somerset.	Edw. Lord	345	2⅜	do	Do.
Nicholson mine	1½ m. SE. of Somerset	Jones & Co	1,728	3	do	Do.
Gordon mine	2 miles E. of Somerset.	Gordon & Simonds	2,073	2⅜	do	Do.
Voyce Bros. mine	do	Voyce Bros	1,500	2⅜	do	Do.
Lumsden mine	Somerset	Lumsden Bros	2,846	3⅜	do	Somerset.
	1 mile N. of Sandyville.		300	1¼	do	Local trade.
Robert mine	3 miles SE. of Carlisle.	Swanner Bros	4,500	4	do	Do.
Ford mine	Ford station	Ruful Ford	1,400	3½	do	C., B. and Q. R. R.
Bryant mine	1 mile south of Hammondsburg.	M. Bryant	280	1¼	do	Local trade.
Dewy mine	3 miles south of Indianola.	Moon & Channel	1,250	2½	do	Indianola.
Graham mine	Indianola	Albert Dennis	275	1¼	do	Do.
	WAYNE COUNTY.					
Happy Hollow mine	Grainville	Peter Ripper	3,000	2½	do	Allerton, Grainville, Warsaw, Corydon, and surrounding country.
	Kniffen		3,000		do	
	WEBSTER COUNTY.					
Greenside mine, upper seam.	Lehigh	H. Greenside	1,600	3½	Bituminous, some sulphur	From Iowa Falls to Cherokee, on Central R. R.
		Mill Bros	1,200		Bituminous	
Corey mine, upper seam	Lehigh	Silas Corey	3,000	4	Bituminous, soft	Parkersburg, Ackley, Anden, Iowa Falls, Webster City, Humboldt, Storm Lake, Cherokee, Lemars.
Tortellott mine	do	O. B. Tortellott	1,500	2½–3½	Bituminous	Local trade.
Crooked Creek C. Co.'s mine, upper and middle seams.	do	Crooked Creek R. R. & C. Co.	18,000	12	do	Ill. Central R. R. and towns along line.
Fort Dodge C. Co. mine, lower seam.	Pleasant valley	Fort Dodge Coal Co	62,000	3–8	do	Local markets for R. R. to Minn. and Dakota.
Black Diamond mine, second seam.	Lehigh	W. C. Beem	7,200	4	do	Local.
Trethan mine	do	John Trethan	312	4	do	
Barrowman mine	do	Barrowman & Sons	4,800	3	do	North as far as Minn.
Brown mine	do	Cuff & O'Connel	700	3½	do	Towns on Iowa Div. of Ill. C. R. R.
Craig mine	Near Coalville	A. Craig	5,000		do	
Hart shaft	do		2,000		do	
Collins mine	do		4,500		do	
Mann mine	Holliday creek		2,000		do	
Merikles mine	Near Coalville		1,100		do	
Irving mine	do		2,500		do	
Hart Bank mine	do	C. Hart	2,500		do	
	do	E. P. Williams	2,500		do	
	do	Wm. Stansberry	2,500		do	

Directory of bituminous coal mines—Continued.

KANSAS.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BOURBON COUNTY.			*Feet.*		
	Dry Wood township	S. Endicott	3,360	7	Bituminous, red, and block	Kansas City, Mo.
	do	J. M. Johnson	5,040	6	do	Do.
	do	Thomas Fowler	6,720	6	do	Do.
	do	G. W. Gipford	8,400	6	do	Do.
	do	A. J. Endicott	3,360	6	do	Do.
	do	John Thombury	3,360	6	do	Do.
	do	B. Bangniss	6,720	6	do	Do.
	do	J. H. Lookinbill	11,760	7	do	Do.
	do	J. F. Lookinbill	13,440	7	do	Do.
	do	E. Pillitt	42,000	6	do	Do.
	do	Samuel Koons	3,360	6	do	Do.
	do	J. W. Stroud	1,680	8	do	Do.
	do	C. Gish	3,360	7	do	Do.
	do	McDonald & Co.	20,160	8	do	Do.
	do	A. Johnson	10,080	5	do	Do.
	do	William Clyborn	5,040	6	do	Do.
	do	P. P. Perry	25,200	6	do	Do.
	do	Seth Pillett	16,800	5	do	Do.
	do	T. Endicott	10,080	6	do	Do.
	do	Robert Mack	6,720	7	do	Do.
	do	E. W. Rundle	11,760	7	do	Do.
	do	William Sawyer	8,440	5	do	Do.
	do	William Simpson	13,440	6	do	Do.
	do	D. N. Phelps	20,160	5	do	Do.
	do	William White	3,360	6	do	Do.
	do	D. Conklin	13,440	7	do	Do.
	do	J. W. Purman	13,440	6	do	Do.
	do	M. Miller	6,720	5	do	Do.
	do	M. Walker	10,080	6	do	Do.
	do	J. E. Boring	16,800	6	do	Do.
	do	J. E. Mayberry	10,080	7	do	Do.
	do	M. W. Miller	3,360	5	do	Do.
	do	T. D. Stroud	10,080	8	do	Do.
	do	L. S. Humphrey	3,360	6	do	Do.
	do	W. Portwood	3,360	6	do	Do.
	do	C. T. Humphrey	1,680	5	do	Do.
	do	John Q. Humphreys	3,360	6	do	Do.
	do	Alex. Given	1,680	6	do	Do.
	do	J. W. Hare	3,360	7	do	Do.
	do	William H. McPherson	1,680	6	do	Do.
	Freedom township	J. W. Boling	130	3	Bituminous	Neighborhood.
	do	N. Oats	800	10	do	Do.
	do	J. R. Wasson	120	11	do	Do.
	Pawnee township	James P. Chanceler	450	4	Bitaminous, block	Home market.
	do	W. H. Longshore	800	5	Bituminous, red and block	Kansas City, Mo.
	do	Eliza Walford	650	5	Bituminous, block	Do.
	do	John Garrison	375	5	Bituminous, red and block	Home market.
	do	—— McNaughton	400	5	do	Do.
	Scott township	Peter Peterson	200	7	Bituminous	Port Scott, Kans.
	do	Henry Mayberry	500	7	do	Do.
	do	Simeon Ferris	600	7	do	Do.
			32,214		do	
	BROWN COUNTY.					
	Irving township	William Evans	400	1½	Bituminous	Brown and Doniphan counties.
	CHATAUQUA COUNTY.					
		Belville & Dunn	50		Bituminous	Local market.
		R. L. Bingon	350		do	Grenola, Kans.
		R. Killpatrick	200		do	Local market.
		James M. Sirley	100		do	Grenola, Kans.
	CHEROKEE COUNTY.					
	Mineral township	Patrick McArdle	400	12	Bituminous	Kansas City, Mo.
	do	Allen & Price	1,000	11	do	Do.
	do	Charles Paggeot	1,270	11	do	Joplin, Mo.
	do	Bartley O'Neal	4,250	11	do	Do.
	Sheridan township	James Rogers	200		do	Hallowell.

Directory of bituminous coal mines—Continued.

KANSAS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CHEROKEE CO.—cont'd.			*Feet.*		
	Sheridan township	B. F. Anbas	200		Bituminous, red and block	Hallowell.
	do	Sarah McKee	7,000		Bituminous	Do.
	do	Henry Robins	2,000		do	Do.
	do	Thomas Carr	10,000		do	Home.
	do	H. Huntsinger	2,500		do	Do.
	Tola township	W. H. Maroison	1,500	2	do	Oswego, Kans.
	Cherokee township	Union Coal Company	12,000		do	Parsons, Kans.
	do	Fred. Blatner	11,000		do	Do.
	do	Lucas & Co	12,500		do	Fort Scott, Kans.
	do	Christian Schmit	11,500		do	Parsons, Kans.
	CLOUD COUNTY.					
	Sibley township	U. Williams	300	1⅔	Bituminous	Kansas and Nebraska.
	do	A. Henderson	1,000	1⅔	do	Do.
	do	Hall & Burk	1,000	2¼	do	Do.
	do	P. M. Montgomery	500	2	do	Do.
	do	S. P. Linn	1,500	2½	do	Do.
	do	C. Murray	1,500	1¾	do	Do.
	Aurora township	Dunn & Alford	700		do	Home market.
Pipe Creek No. 1 mine	Meredith township		2,000	3	do	Cloud and adjacent counties.
	COFFEY COUNTY.					
	California township	Dedery Kiser	650	10	Bituminous, block	Emporia and Burlington.
	do	Cyrus A. Ball	688	10	do	Do.
	do	Henry Jacobs	325	11	do	Do.
	do	C. Humphrey	500		do	Do.
	CRAWFORD COUNTY.					
	Sheridan township	Perry Enlow	480	6	Bituminous	Home.
	do	William Quinnon	500	6	do	Do.
	Osage township	Isaac Vance	400	6	do	Farmers.
	Lincoln township	John Perry	5,760		do	Kansas City, Mo.
	do	Isaac Kendall	1,000		do	Finley City, Kans.
	do	Keith & Henry	8,000		do	Kansas City, Mo.
	do	A. Harris	5,760		do	Coal Vale, Kans.
	do	J. A. Bovard & Co	6,000		do	Kansas City, Mo.
	do	Thompson & Robuck	400		do	Coal Vale, Kans
	Washington township.	Jesse Carpenter	300		do	Surrounding country.
	do	Cornelius Dale	400		do	Girard, Osage, and Missidon, Kans.
	do	Henry McKahans	200		do	Grant and Crawford townships, Kans.
	do	John H. Dale	150		do	Southern Kans. and Mo.
	Baker township	Albert Stotts & Bro	600	7	do	New Pittsburgh, Kans.
	do	Cambell & Jones	900	8	do	Do.
	do	Holden Lesley	2,000	11	do	Do.
	do	A. S. Warren	1,500	9	do	Do.
	do	George Cook	600	9	do	Kansas City, Mo.
	do	George Pearson	1,500	5	do	Custova Bank.
	DOUGLAS COUNTY.					
	Eudora township	John Kreiser	240		Bituminous	Eudora and vicinity.
	FRANKLIN COUNTY.					
	Greenwood township	Bagby & Pulse	500		Bituminous	Ottawa, Kans.
	do	J. Dyer	1,000		do	Ottawa and Pomona.
	do	Bledroe Bros	400		do	Ottawa, Kans.
	do	R. J. Dyer	500		do	Do.
	do	Huchings & Pyer	1,000		do	Do.
	do	Jacob Bush	500		do	Ottawa and Williamsburgh.
	Centropolis township	Reuben Hackett	600		do	Ottawa and vicinity.
	Williamsburgh township.	Rinsbatch & Price	600		do	Ottawa, Kans.
	do	Geo. Cable	400		do	Ottawa and country.
	do	J. H. Ransom	7,500		do	Ottawa, Kans.
	do	J. B. Richel	700		do	Do.
	do	Robert Riley	400		do	Do.
	do	A. J. Hamilton	200		do	Ottawa and country.
	GREENWOOD COUNTY.					
	Eureka township	Francis H. Clarke	600		Bituminous	Eureka, Kans.

Directory of bituminous coal mines—Continued.

KANSAS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LABETTE COUNTY.			*Feet.*		
	Oswego township	S. M. Gramey	280	1⅝	Bituminous	Oswego, Kans.
	do	O. Whitney	320	1⅝	do	Do.
	do	J. W. Burgis	270	1⅝	do	Do.
	do	Thos. A. Burgess	400	1½	do	Labette county, Kansas.
	do	Dan'l Shepherd	400	1½	do	Oswego, Kans.
	Richland township	Albert Onsted	320		do	Do.
	do	Marion Timons	480		do	Chetopah, Kans.
	do	John Sastine	490		do	Do.
	do	Geo. Powers	300	3	do	Do.
	LEAVENWORTH COUNTY.					
	Kickapoo township	Leavenworth Coal Co	60,000	2	Bituminous	Kansas.
	Fairmount township	Thos. C. Brockette	588		do	Tonganoxie, Kans.
	LINN COUNTY.					
		Henry Carbon	800	1½	Bituminous	Mound City.
	Potosi township	Samuel Barker	3,000	10	do	Pleasanton, Kans.
	do	John L. Keenan	2,000	10	do	Do.
	do	Joshua Hibson	2,000	10	do	Do.
	do	Elizabeth Ford	1,500	10	do	Do.
	Stanton township	A. M. Lambert	600	2	do	Linn county, Kans.
	Sheridan township	Wm. J. Pritchett	640	6	do	Prescott, Kans.
	do	Caleb G. Deming	1,200	2	do	Do.
	MONTGOMERY COUNTY.					
	Sycamore township	Wm. Dixon	375		Bituminous	Independence.
	NEOSHO COUNTY.					
	Chetopah township	Munroe Powell	400		Bituminous	Thayer, Kans, local market.
	do	J. H. Adams	300		do	Thayer and Neosho and Quaming counties, Kansas.
	OSAGE COUNTY.					
	Barclay township	John S. Firey	150	1½	Bituminous	A., T. and S. F. R. R.
	do	Louis Humphrey	800	1	do	Hutchinson.
	do	Calvin Abbot	300	1½	do	A., T. and S. F. R. R.
	do	Jos. Saunders	200	1½	do	Country towns.
	Dragoon township	Kansas City Min. Co.	18,000	2½	do	A., T. and S. F. R. R.
	do	Underwood & Davis	9,000	2½	do	Do.
	do	Shrunk, More & Rooks	3,000	1½	do	Home sale at bank.
	do	Eureka Co	675	2¾	do	A., T. and S. F. R. R.
	do	Sheldon & Marshall	780	2	do	Do.
	Olivet township	Andrew Johnson	560		do	Farmers of township.
	Superior township	J. F. Martin and Co.	432		do	Carbon C. and M. Co.
	do	E. A. Clift	2,250		do	Do.
	do	Thomas & McCrea	1,250		do	Do.
	do	Western C. and Min. Co	2,925		do	A., T. and S. F. R. R.
	do	J. A. Drake	360		do	Osage City.
	do	J. S. F. Greene	300		do	Peterton.
	do	W. H. Close	60		do	Topeka, Kans.
	do	C. H. Conden	1,550		do	Wichita, Kans.
	do	William Lloyd	750		do	Osage City.
	do	D. S. Martin	1,500		do	Do.
	do	Jos. Dupriez	6,000		do	Wachita, Newton, and Hutchinson.
	do	John Anderson	400		do	
	Ridgeway township	Robert McKee & Co	4,800		do	Topeka.
	do	Jas. Hynd	300		do	Country trade.
	do	Thomas Thurtchly	100		do	Do.
	do	Woetzig Bros	320		do	Do.
	do	Daniel Smith	300		do	Do.
	do	William L. Greene	12,000		do	R. R. and local trade.
	do	Richard Evans	600		do	Lawrence, Kans.
	do	Fred. Holten	600		do	U. P. R. R.
	do	Carbon Coal Co	11,200		do	Kansas.
	do	William Brown	1,500		do	Local trade.
	do	Thomas Trotter	400		do	Country trade.
	do	Jos. Prescott	250		do	Local trade.
	Osage City	Scandinavian C. and M. Co.	12,000		do	Southern and Western Kansas.

Directory of bituminous coal mines—Continued.

KANSAS—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	OSAGE CO.—cont'd.			*Feet.*		
	Osage City	Carbon C. and Min. Co	4,320		Bituminous	
	do	Osage Co. C and M. Co	28,000		do	Newton, Kans.
	Agency township	L. Cunningham	600		do	At mine.
	REPUBLIC COUNTY.					
	Grant township	Smith Bros	400		Bituminous	Country market.
	SHAWNEE COUNTY.					
		Robert Forbes	7,850		Bituminous, hard	Topeka and Silver Lake.
	Topeka township	Southerin & Thatcher	480	1½	Bituminous	Topeka, Kans.
	Missouri township	William Pears	400	4	do	Do.
	do	C. W. Jewell	600	1¼	do	Do.
	do	C. O. Knowles	600	1¼	do	Do.
	do	G. G. Gage	1,000	1¼	do	Do.
	do	L. A. Coville	500	1½	do	Do.
	do	S. W. Smith	60	1½	do	Do.
	do	T. W. Sudder	1,000	1¼	do	Do.
	WOODSON COUNTY.					
		Christian Phelps	200	10	Bituminous	Local.
	Toronto township	William Riemke	160	4	do	Yates Centre, Kans.

KENTUCKY.

	BOYD COUNTY.					
Coalton & Rush mine, No. 7 seam.	Coalton	Ashland C. and L. Ry. Co	202,091	4	Bituminous, block	Own furnace, Cincinnati, Louisville, and small towns on Ohio river.
	BREATHITT COUNTY.					
Cannel mine, No. 5 seam	Spicer's branch	Granville Spicer	500	3½	Bituminous	Irven, Muddy Creek, Boonesborough, Clays' Ferry, Hickman, Clifton, and Frankfort.
	BUTLER COUNTY.					
Mining City mine	Mining City	James Philips	15,000	3⅜	Bituminous, red ash, laminated.	Bowling Green, Ky.
Aberdeen mine, Aberdeen seam.	Aberdeen	John Mathias	2,000	3½	Bituminous	Do.
	Rochester	Taylor & Co	488		do	Neighborhood and home.
	CARTER COUNTY.					
Star mine, No. 7 seam	Star furnace	Norton Iron Works	45,126	4	Bituminous, block	Norton Iron Works, Ashland, Ky.
	CRITTENDEN COUNTY.					
Lamb mine, No. 1 seam	Tradewater river	John M. Lamb	5,000	3 7/12	Bituminous, block	Tradewater river and Ohio river steamboats.
Christian Barnaby and J. M. Lamb mine, No. 1 seam.	do	Christian Barnaby and J. M. Lamb.	8,000	3½	Bituminous	Do.
Bell mine	Near Caseyville	Lon Alrick	2,000	4¼	Bituminous, block	Tradewater river and Caseyville.
	DAVIESS COUNTY.					
Herr mine, No. 9 seam	Owensborough	H. C. Herr	3,570	3⅜	Bituminous	Owensborough.
Bon Harbor mine	Bon harbor farm	Henman & Co., M. Shafer & Co., J. Holland.	4,800	4⅜	Bituminous, hard, bright, domestic.	Owensborough, adj. country. and steamboats on Ohio river.
	GREENUP COUNTY.					
Fulton C. Works mine, Nos. 2, 3, and 4 seams.	Wurtland	J. R. & W. Ryan	10,000	8⅜	Bituminous	Maysville, Cincinnati, and points on Ohio river.
	HANCOCK COUNTY.					
Hancock mine	Near Horsville	Amer. Cannel C. Co	21,180	2¼	Bituminous	Steamboats on Ohio river and tributaries.
Bergenroth mine, No. 1 seam.	Horsville	Bergenroth Bros	2,500	3¾	Bituminous, cannel	Hawsville and Amer. Cannel C. Co.
	HENDERSON COUNTY.					
Henderson C. and M. Co., No. 9 seam.	Henderson	Henderson C. and M. Co.	10,000	4	Bituminous, hard, non-coking	City and country trade.
People's mine, No. 9 seam	do	P. J. McNamara	5,640	4	Bituminous, block, hard, some sulphur.	Henderson.
William Jones mine, No. 9 seam.	Green river	William Jones	1,950	4	Bituminous	Along first part of Green river.
Spottsville mine	Spottsville	T. Shiver & Bro	43,533	4	Bituminous, bright, heating	Evansville and New Orleans.
	HOPKINS COUNTY.					
Earlington mine, Nos. 9 and 11 seams.	Earlington	St. Bernard's C. Co	108,502	11½	Bituminous	Nashville, Henderson, Hopkinsville, Goshen, and Evansville, via Henderson and Nashville branch of Louisville and Nashville R. R.

Directory of bituminous coal mines—Continued.

KENTUCKY—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	HOPKINS CO.—cont'd.			*Feet.*		
St. Charles mine, Nos. 9 and 11 seams.	St. Charles	St. Bernard's C. Co	80,000	12	Bituminous	Louisville, Paducah, Memphis, Tenn., and N. Orleans, via Paducah and Elizabethtown R. R., and Tenn., Ohio, and Miss. rivers.
Hecla C. and Min. Co., Nos. 9 and 11 seams.	Earlington	Hecla C. and Min. Co	29,680	12	do	Nashville, Tenn., Clarksville, Brownsville, Memphis, Tenn., and Hopkinsville, Ky.
Diamond mine, No. 9 seam	Morton's Gap	Morrow & McNary	12,000	5	do	Nashville.
Williams mine	Petersburgh	S. Harris & Co	None.	5	Bituminous, bright	Nashville, Hopkinsville, and Clarksville.
	LEE COUNTY.					
Pryse & Beatty mine, sub-conglomerate seam.	Beattyville	E. M. & Thomas Pryse	16,200	3½	Bituminous, block	Clay's Ferry, Hickman, Tyrone, Clifton, and Frankfort.
Meyer's Branch mine, sub-conglomerate seam.	Meyer's branch	Thomas J. Phillips	3,000	3	do	Do.
Steel mine	Proctor	Daniel Steel	45	3½	do	Boonesborough, Clay's Ferry, Hickman, Grey's Creek, Clifton, and Frankfort.
South Fork mine	Proctor	Daniel Scott and John M. Davidson.	3,600	4	Bituminous, block	Boonsborough, Clay's Ferry, Hickman, Grey's Creek, Clifton, Tyrone, and Frankfort.
Mick's Branch mine	Beattyville	C. M. Beach and W. P. Hill.	500	4	Bituminous, splint	Do.
Clark mine	do	R. C. Hill	1,500	3	Bituminous	Frankfort and Hickman, Ky.
	do	C. M. Beach	760		do	Neighborhood.
	do	C. D. Tyler	760		do	Do.
	do	John Maxey	608		do	Do.
	M'LEAN COUNTY.					
	Island Station	R. H. Everly	760		Bituminous	Neighborhood and home.
	do	R. M. Karnes	395		do	Do.
	MADISON COUNTY.					
Moran mine	Big Hill	W. B. Jones	600	3⅓	Bituminous, block	Portion of Madison county south of Richmond.
	do	Jeff. Cox	1,330		Bituminous	Neighborhood.
	MENIFEE COUNTY.					
Cornwell & Cord mine, sub-conglomerate seam.	Cornwell	William Strofer	2,750	2⅓	Bituminous, hard	Mount Sterling, Winchester, and Lexington, Ky.
Campbell & Lindsay mine, No. 1 seam.	Rothwell	Campbell & Lindsay	11,400	2½	Bituminous	Mount Sterling and Lexington, Ky.
	MORGAN COUNTY.					
Pieralt mine, No. 4 seam	Black Water	Pieralt & Co	380	3½	Bituminous, cannel	Mount Sterling.
	MUHLENBURGH COUNTY.					
Mercer mine, No. 9 seam	Mercer station	Tapp & Brizendine	26,000	4½	Bituminous, steam and grate	Louisville, Paducah, Ky., Tenn., and Miss., via Paducah and Elizabethtown R. R and connecting lines.
Guylena mine, No. 11 seam	Owensborough junct'n	do	7,560	4⅝	Bituminous, bright, best English coal.	Owensborough and Louisville, Ky., via Paducah and Elizabethtown R. R., Louisville and Nashville R. R., Owensborough and Nashville R. R.
Rop mine, Nos. 11 and 12 seams.	do	C. C. Lashbrook	3,000	4½	Bituminous, very hard, almost equal to anthracite.	Owensborough and Louisville, via Owensborough and Nashville R. R., Paducah and Elizabethtown R. R.
Green River mine, No. 11 seam.	Painestown	Green River I. and C. Co.	10,800	5⅔	Bituminous, bright, domestic and steam.	Louisville, via Paducah and Elizabethtown R. R., and Louisville and Nashville R. R.
Kentucky mine, No. 11 seam.	Mercer station	W. H. Dovey	13,278	5½	Bituminous, coking	Louisville, Paducah, Elizabethtown, and points on St. L. N. R. R. in Tenn. and Miss.
Muhlenburg mine, No. 11 seam.	Muhlenburg	Tapp & Brizendine	18,000	6	do	Louisville, Ky., Tenn., Miss., Chicago, St. Louis, N. O. R. R.
McDougall mine, No. 11 seam	Paradise	John McDougall	None.	6	Bituminous, iron, gas, steam, and grate.	Bowling Green, Paradise, and Calhoun.
	OHIO COUNTY.					
Rockport mine, No. 9 seam	Rockport	Smith, Doherty, Keath & Co.	4,621	5	do	Louisville, Paducah, and towns south of P. as far as Miss., via P. and E. R. R., and L. and W. R. R.
McHenry mine, No. 9 seam	McHenry	H. D. McHenry and W. G. Duncan.	45,656	4½-5⅛	Bituminous	Louisville, Jackson, Tenn., for Mobile and Ohio R. R., via P. and E R. R., L. and N. R. R., and M. P. and N. R. R.
Emporia mine, No. 9 seam	Emporia	Mercer Bros	3,004	4⅜	Bituminous, some sulphur	Jackson, Louisville, and Paducah.
Sulley mine, No. 9 seam	Cromwell	M. Stanley	12,000	4½	Bituminous	Bowling Green.
Render C. Co.'s mine, No. 9 seam.	Hamilton	Render C., I., Min., and Mfg. Co.	12,800	4⅝	Bituminous, steam and domestic.	Louisville.

Directory of bituminous coal mines—Continued.

KENTUCKY—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	PULASKI COUNTY.			*Feet.*		
Addison Branch mine, middle subconglomerate seam.	Pulaski	Thos. Raybourn	8,000	4	Bituminous	Nashville and Cumberland river.
Cumberland Coal Co.'s mine	Greenwood	Cumberland C. Co	7,850	3–3½	do	R. S. R. R. Co., Danville, Harrodsburg, and Nicholasville.
McKean mine, first subconglomerate seam.	Thompsonville	L. Edwards & Son	1,600	3½	Bituminous, block	Nashville, Tenn., and towns on the Cumberland river.
	ROCKCASTLE COUNTY.					
Pine Hill Coal Co.'s mine	Pine Hill	C. Crooke	30,000	2¾	Bituminous	Louisville, Lebanon, Danville, Harrodsburg, Stanford, Lancaster, Richmond, via L. and V. R. R. Co.
Happy Hollow C. Co.'s mine, block seam.	do	Taylor & Co	7,200	2⅜	do	Points on Louisville, Nashville and Cincinnatti Southern R. R.
Thompson & Landaman mine, subconglomerate seam.	Livingston station	Thompson & Landaman.	1,400	2½	do	Richmond, Lancaster, Lebanon, and adjacent country.
Diamond Block mine, double subconglomerate seam.	Pine Hill	R. Draimond	1,000	2½	do	Louisville, Lebanon, Harrisburg, Stratford, and Richmond.
	UNION COUNTY.					
Casey mine, No. 11 seam	Caseyville	Jno. W. Cardwell	712	3	Bituminous, bright	Steamboats on Tradewater river.
Casey mine, Bell seam	do	Cooper & Cook	5,336	3½	Bituminous, semi-cannel	Western.
Shotwell mine	De Konn	P. G. Kelsey & Co	50,230	7 5/12	Bituminous, block cannel	Memphis, Vicksburg, and mouth of White river, via Ohio and Miss. rivers.
J. M. Davis mine, No. 1 seam	Caseyville	J. M. Davis	2,000	3	Bituminous	Steamboats on Ohio river.
Nelson mine	do	M. M. Nelson	52,0	3½	Bituminous, block	Do.
Hall & Owens mine, No. 1 seam	Near Caseyville	Hall & Owens	2,000	4½	do	Local trade.
	Caseyville	Dare Wallace	600		Bituminous	Neighborhood.
	WEBSTER COUNTY.					
Bowls mine, No. 8 seam	Providence	R. H. Bowls	2,235	4	Bituminous, bright	Providence, Dixon, and adj. country.
Kate Gerins, No. 9 seam	do	T. K. Gerins	307	3½	do	Do.

MARYLAND.

	ALLEGHANY COUNTY.					
C. I. and Oil Co., and Koontz, Big Vein, and Midlothian mines, Big seam.	Midlothian and Lonaconing.	New Central C. Co	388,640	7¾	Semi-bituminous	New York and New England.
Borden shaft, Big seam	Frostburgh	Borden Mining Co	163,925	11	do	Do.
Borden mine, Big seam	do	do	29,812	9	do	New England.
Blaen, Avon C. Co.'s mine, Big seam.		Blaen, Avon C. Co	55,920	8	do	New York, Baltimore, Boston, and Providence.
Lonaconing mine, Big seam	Lonaconing	George's Cr. C. and I Co.	223,476	10	do	New England, Baltimore, and District of Columbia.
Savage mine, Savage seam	Mt. Savage	Union Min. Co	4,028	2¼	do	Home consumption.
Bowery mine, 14 foot seam	Bowery furnace	Cumberland C. and I. Co.	7,047	12½	do	Do.
Calodonia mine, Big seam	Barton	American Coal Co	None.	8	do	New England, New York, and New Jersey.
Jackson mine, Big seam	Lonaconing	do	121,281	10	do	Do.
Swanton mine, Cumberland seam.	Barton	Stephen S. Lee & Son	51,050	10	do	Baltimore and Eastern markets.
Piedmont mine, Big and 3-foot seams.	do	Piedmont C. and I. Co.	11,200	11	Bituminous	Baltimore, Philadelphia, and Boston.
Rutland mine, 14-foot seam	Western Port	Hampshire and Balt. C. Co.	98,135	11	Semi-bituminous	Baltimore.
Midland mine, 14-foot seam	Midland	do	12,827	14	do	Alexandria.
National mine, 14-foot seam		do	19,222	10	do	Do.
Potomac Coal Co.'s mine, 14-foot seam.	Barton	Potomac Coal Co	92,380	8	do	Baltimore and Boston.
New Reading or Canton mine, 6-foot seam.	New Reading		None.	5	Bituminous	
Savage, Mountain, Detmold, and Kingsland mines, Big seam.	Lonaconing	Maryland C. Co	89,749	7½	Semi-bituminous, steam and blacksmith.	New England and the United States.
Grant Coal Co.'s mine	Near Pompey Smash	Grant Coal Co	73	7	do	Baltimore and Georgetown, D. C
Ocean No. 1 mine, Big seam	Ocean	Consolidation C. Co	116,520	10	do	Eastern cities on Atlantic seaboard north of Norfolk Va.
Ocean No. 2 mine, Big seam	Near Frostburgh	do	3,997	10	do	Frostburgh.
Ocean No. 3 mine, Big seam	Near Hoffman	do	332,956	10	do	Eastern cities on Atlantic seaboard north of Norfolk, Va.
Ocean No. 4 mine, Big seam	Near Frostburgh	do	158,569	10	do	Do.
Hamill mine, Big seam	On. C. and P. R. R.	Md. Union C. Co	138,468	14	Semi-bituminous, smithing, manufacturing, and steam.	As far west as Nebraska and the east and Atlantic seaboard.

Directory of bituminous coal mines—Continued.

MARYLAND—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ALLEGHANY CO.—cont'd.			*Feet*		
Atlantic mine, Big seam	Pekin	Atlantic and George's Creek Consolidated C. Co.	73,898	7½	Semi-bituminous	Baltimore.
	Western Port	G. W. Spangler	1,800		Semi-bituminous	Piedmont, Md.
	Election district No. 1.	Hensel & Kidmore	3,000	9	do	Frostburgh.
	Election district No. 12.	Thomas W. Neff	500	4	do	Cokhart Village.
	Barrallville	Fred. Currie	500	9	do	Local.
	GARRETT COUNTY.					
North Branch Co.'s mine, Nos. 1 and 2 seams.	Bloomington	William A. Bryden	840	9	Semi-bituminous, free burning.	Baltimore and the east, local on line of B. and O. R. R., and west of Ohio river.
Empire mine, 6-foot and 4-foot seams.	do	Piedmont C. and I. Co	4,480	8	Semi-bituminous	Baltimore and line of B. and O. R. R.
George's Creek mine, Big seam.	On C. and P. R. R	Md. Union C. Co	23,450	14	Semi-bituminous, smithing, manufacturing, and steam.	As far west as Nebraska, and the east and Atlantic seaboard.
	Bloomington	Charles A. Muller	600		Semi-bituminous	Bloomington, etc.
	do	Thomas Michaels	400		do	Bloomington and Western Port.

MICHIGAN.

	JACKSON COUNTY.					
	Blackman	Eureka Coal Co	20,000	3⅝	Bituminous	Jackson.
	do	Michigan Coal Co	800	4	do	Do.
	Jackson	James & Evans	5,500	3	do	Do.
	do	Jackson Coal Co	55,000	3½	do	Do.
	do	do	4,500	3½	do	Do.
	SAGINAW COUNTY.					
	Saginaw township	Samuel Shattuck	None.		Cannel	
	SHIAWASSEE COUNTY.					
	Corunna	Corunna Coal Co	15,000		Bituminous	D., T. H. and M. R. R. and sundry cities in Michigan.

MISSOURI.

	ADAIR COUNTY.					
	Nineveh township	John D. Miller	None.		Bituminous	
	do	Hannibal C. Co	3,264	3	Bituminous, hard	Quincy R. R. Co.
Besauko mine	do		1,200	4	do	Kirksville, Mo.
	AUDRAIN COUNTY.					
		J. A. Judy	1,174	2½	Bituminous	Mexico, Mo.
	BARTON COUNTY.					
	Le Roy township	J. W. Eastas	1,524	1½	Bituminous	Parry Switch, Mo.
	do	J. McDusmott	5,000	2½	do	Finley City, Kans.
	do	John Parry	10,000	2½	do	Do.
	do	Thos. Reese	5,000	1½	do	Parry Switch, Kans.
	Central township	Saml. Geivet	190	6	Bituminous, block	Lamar, Mo.
	Richland township	Ansel Church	400	15	Bituminous	Barton county, Mo.
	BATES COUNTY.					
	New Home	Ward Bros	4,000	5	Bituminous	Butler and vicinity, Mo.
	do	G. W. Wagoner	2,500	5	do	Bates and adjoining counties.
	do	Wm. Griggs	3,000	5	do	Do.
	do	Wm. Karr	2,800	5	do	Butler and vicinity, Mo.
	do	M. Wolfe	2,500	1	do	Do.
	do	G. Shafer	2,000	5	do	Bates county.
	Homer	Benj. Good	400	3	do	Country trade.
	do	Ephraim D. Warner	25	4	do	Do.
	do	John P. McGaw	160	3	do	Do.
	do	Nelson Cole	None.	3	do	Do.
	Prairie township	Thos. Gunnerson	500	3	do	Local.
	do	do	600	2	do	Do.
	do	E. Shafer	600	2½	do	Do.
	Deer Creek township	John Mondy	300		do	Harrisville, Mo.

Directory of bituminous coal mines—Continued.

MISSOURI—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BOONE COUNTY.			Feet.		
		D. W. McQuitty	400	2	Bituminous	Rocheport.
	CALLAWAY COUNTY.					
		S. B. Lee	320		Bituminous	Fulton City.
		Martin Reid	480		do	Do.
	CARROLL COUNTY.					
	Carrollton township	Ely Smith	1,600		Bituminous, soft	Carrollton.
	CHARITON COUNTY.					
	Yellow Creek	Riddell & Allen	100	2	Bituminous	Home.
	do	T. P. Wilkerson	150	2	do	Do.
	do	Mo. M. Smith	140	2	do	Do.
	do	Gordon Frank	200	2	do	Do.
	COLE COUNTY.					
	Marion township	James A. Elston	250		Bituminous	Jefferson City, Mo.
	do	Thomas Casperi	660		do	Do.
	COOPER COUNTY.					
	Boonville township	Daniel G. Davis	600		Bituminous	Boonville, Mo.
	do	James R. Sloan	400		do	Do.
	do	Weber & Vollrath	500		do	Do.
	do	Weber & Co	6,500		do	Boonville and state.
	DADE COUNTY.					
	Cedar township	McIntosh & Workman	560	8	Bituminous	At mine.
	HENRY COUNTY.					
		Peter Dubuque	450	6	Bituminous	Montrose and country.
		William Drummond	1,000		do	Montrose.
		Nathan Virrs	225	6	do	Montrose and country.
	Clinton township	John Hudspeth	20,000		do	Sedalia, Mo.
	do	J. M. Swavely	1,680	2½	do	Clinton, Mo.
	do	Bridges & Co	578	2¾	do	Sedalia, Mo.
	do	C. W. Jordan	2,400	3	do	Do.
		Osage C. and Min. Co	30,000	4	do	M. K. and T. R. R.
	JOHNSON COUNTY.					
	Madison township	P. H. Rhea	300	10	Bituminous	Holden, Mo.
	do	M. Parkhurst	500	6	do	Do.
	do	James Moore	500	6	do	Do.
	do	William Lapesh	610	6	do	Do.
	Warrensburgh	W. Thompson	5,000		do	Warrensburgh.
	LA FAYETTE COUNTY.					
Windsor mine		Windsor Coal Co	16,000		Bituminous	C. and A. R. R.
	Wellington	J. C. McGrew	3,396		do	Kansas City, Mo.
	do	Andrew Carler	720		do	Do.
	Lexington township	Reid, Waddell & Taylor.	20,144		do	Do.
Reid & Waddell mine	do		10,929		do	Do.
	do	Reid, Waddell & Davis	8,554		do	Do.
	do	J. W. Grudy & Co	2,800		do	Do.
	do	O'Melley	6,000		do	Do.
	do	Thomas B. Clagett	1,500		do	Lexington.
	do	J. H. Graham	208		do	Do.
	do	William T. Bell	2,000		do	Do.
	do	Henry Macey	900		do	Kansas City, Mo.
	Sinabar township	Thomas Perrie	400		do	Odessa and Bates, Mo.
		John Wollenman	900		do	Dover and River, Missouri.
		James Harrison	205	2	do	Steamboats.
		Bartley & Williams	1,100	3¼	do	La Fayette county, Missouri.
	LINN COUNTY.					
	Yellow Creek township		150	1½	Bituminous	Brookfield, Mo.
	do		175	1½	do	Do.
	LIVINGSTON COUNTY.					
	Chillicothe township	William Cox	500		Bituminous	Chillicothe, Mo.
	do	Abel Cox	800		do	Grundy and Livingston.
	Mooresville township	Charles W. Garlick	500	1½	do	Breckenridge, Mo.

Directory of bituminous coal mines—Continued.

MARYLAND—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MACON COUNTY.			*Feet.*		
	Hudson township	Chas. Magms	500		Bituminous	Macon city.
	do	Wm. Chope	600		do	Do.
	do	Willis Dameron	600		do	Do.
	do	Jas. House	520		do	Do.
	do	Chas. Fortner	400		do	Do.
	do	Wm. Rosey	500		do	Do.
	Narrows township	W. H. Jones & Co	15,600		do	Moberly and Queen City.
	Lyda township	Richard Hartwell	250	1½	do	La Plata, Mo.
	Bevier township	Louis & Snively	50,000	4	do	Miss. and Mo.
	do	Oakdale C. Co	25,000	4	do	Mo., Kans. and Nebr.
	do	Thos. Wadell	15,0 0	4	do	Do.
	do	M. C. and M. Co	42,000	4	do	Do.
	Lingo township	T. M. Jobson	2,500	4	do	St. Joseph and Kansas City, Mo.
	Independence tw'p	John Branhan	100	2	do	La Plata, Mo.
	Round Grove	Isaac Gee	1,950	2	do	Hannibal, Mo.
	MONTGOMERY COUNTY.					
	Prairie township	Dan'l Ulrich	500		Bituminous	Middletown and Ashley.
	do	Jas. Schindler	390		do	Wellsville and Middletown.
Six mines			1,410		do	
	NODAWAY COUNTY.					
	Green township	George Monahan	367	1¼	Bituminous	Maryville, Mo.
	do	David J. B. Kimball	280	1⅛	do	Do.
	do	N. H. Hichings	160	1 1/12	do	Do.
	do	Wm. Pascol	655	1¼	do	Do.
	do	Rufus Ellsworth	240	1¼	do	Quitman, Mo.
	do	John Neely	240	1¼	do	Maryville, Mo.
	do	Wm. Holt	240	1¼	do	Do.
	do	Troget Putner	160	1⅛	do	Do.
	PUTNAM COUNTY.					
	Grant township	J. W. Wells	100		Bituminous	Moalton and Iowa.
	Lincoln township	E. G. Holloway	1,000	3	do	Unionville, Mo.
	do	L. Ketchaw & Brother	14,000	3½	do	Burlington, Iowa.
	RALLS COUNTY.					
	Jasper township	J. M. Lambuilt	200	2⅔	Bituminous	Adjoining counties.
	RANDOLPH COUNTY.					
	Prairie township	Jackson C. and M. Co	19,200	4	Bituminous	Kansas, Mo., Wab., St. L. and P. R. R. Co.
	do	R. D. Blair & Co	20,000	3½	do	Mexico, Mo., and C. and A. R. R.
	do	Perch Coal Co	960	4	do	Glasgow, Mo.
	do	Osage C. and Min. Co	15,000	3½	do	M., K. and T. R. R.
	Sugar Creek township	Huntsville C. and Min. Co.	3,600	4	do	Kansas City.
	do	John B. Williams & Co.	700	4	do	Moberly, Mo.
	Jackson township	Ballot & Amick	1,400	10	do	Jacksonville and vicinity.
	Salt Spring township	James Baly & Co	13,140		do	Council Bluffs, Mo.
Carbon mine	do		4,320	4 1/12	do	Kansas City.
	Hunterville township	Independent C. and M. Co.	12,000	4	do	Do.
	do	G. W. Taylor	1,800	4	do	Kansas City and Omaha.
	do	Stewart C. and M. Co	27,500	4	do	Brunswick, Stanbury, Kansas City, and Moberly.
	Silver Creek township	John Gibson	125	1⅔	do	Mount Airy, Clifton, and Roanoke.
	RAY COUNTY.					
		J. C. McGrew	20,000	2	Bituminous	Kansas City, Mo.
		Thomas & Co	2,000	2	do	Do.
		Ernst & Crasen	200	2	do	Do.
		C. Burnett	2,500	2	do	Do.
	Richmond township	Hirtley & Wilds	1,800		do	Richmond and Saint Joseph.
	do	Stotwell & Co	None.		do	Saint Joseph.
	do	J. R. Hauncher	530	2	do	Richmond, Mo.
	do	D. T. Duval	1,000	2½	do	Do.
Russel mine	Crooked River twp		450		do	Norborne.
Eckke mine	do		500		do	Hardin.
Esry mine	do		500		do	Norborne.

Directory of bituminous coal mines—Continued.

MARYLAND—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	SAINT CHARLES COUNTY.			*Feet.*		
.....	Saint Charles township	Michael Beckerle	2,400	2½	Bituminous	Saint Charles, Mo.
.....	do	Jacob Jungerman	2,000	2½	do	Do.
.....	do	E. C. Cunningham	1,500	2½	do	Do.
	SAINT CLAIR COUNTY.					
.....	Appleton City	E. A. Adams	400	1½	Bituminous	Appleton City.
.....	do	F. Johnson	950	1	do	Do.
	SALINE COUNTY.					
.....	Blackwater township	John Lauer	720	.....	Bituminous	Marshall, Mo.
.....	Clay township	William Hunter	100	.....	do	Saline county.
.....	do	Caine Davis	800	.....	do	Do.
.....	do	W. Pennock	500	.....	do	Do.
.....	do	J. P. Copeland	1,000	.....	do	State of Mo.
.....	do	Sarah Johnson	100	.....	do	Saline county.
.....	do	Charles Brown	200	.....	do	Do.
.....	Arrowrock township	J. Sappington	5,000	.....	Bituminous and cannel	Marshall, Mo.
.....	Jefferson township	B. C. Gains	15	.....	Bituminous	
.....	do	C. W. Hall	7	.....	do	
	SULLIVAN COUNTY.					
.....	Duncan township	George Hughes	1,500	.....	Bituminous	Browning, Mo.
Westlake's Bank mine	Buchanan township	.....	100	2	do	Buchanan township and Pollock.
	VERNON COUNTY.					
.....	.....	Arch. Thompson	720	5	Bituminous	Clayton, Mo.
.....	Virgil township	Richard H. O'Neal	110	7	do	Farm houses.

MONTANA TERRITORY.

	GALLATIN COUNTY.					
Chestnut mine	8 miles east of Bozeman.	Jas. D. Chestnut	224	6½	Lignite, coking	Bozeman and Fort Ellis.

NEBRASKA.

	PAWNEE COUNTY.					
.....	Southfork township	Victor Allarge	200	.....	Bituminous	Pawnee City.

NORTH CAROLINA.

	CHATHAM COUNTY.					
Gulf mine	Gulf	E. L. Houghton	350	6½	Bituminous	Raleigh, Charlotte, Fayetteville and Lawrenceburg.
Egypt mine	Egypt	.....	None.	4½	Bituminous, coke	Raleigh, Fayetteville, Portsmouth, and Wilmington.

OHIO.

	ATHENS COUNTY.					
Lick Run mine, No. 6 seam	Lick Run	W. A. Shoemaker & Co.	20,000	7	Bituminous, open-burning	Columbus, via C. and H. V. R. R. and north and west.
Ingham's mine, No. 6 seam	Kings	King Bros	4,020	2½	do	Towns westward on line of M. and C. R. R.
Poston & Pendleton mine, Nos. 6 and 7 seams.	Nelsonville	Poston & Pendleton	51,490	6½	Bituminous, white ash, open-burning.	Via C. and H. V. R. R., Ohio canal, and M. and C. R. R.
Hocking Valley C. and Salt Co.'s mine.	Chauncey	Hocking Valley C. & Salt Co.	3,453	6	Bituminous, open-burning	Own use and neighborhood.
Floodwood mine, No. 6 seam	Floodwood	B. B. & N. B. Sheffield	20,000	5 5/12	do	Via C. and H. V. R. R. to Columbus, thence north and northwest.
Hamley Run mine, No. 6 seam.	Hamley run	H. C. Will & Co	11,051	6	do	Via C. and H. V. R. R., and Detroit.
Nelsonville C. Min. Co.'s, Nelsonville seam.	Nelsonville	Nelsonville C. Min. Co.	16,520	6	do	Ohio, Ind., Mich., and Ill.
Akron Furnace mine, No. 6 seam.	Buchtel	Akron Iron Co	75,000	6½	Bituminous, open-burning, iron manufacturing.	Detroit, Mich., Rich., Ind., northern and western Ohio, etc.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ATHENS CO.—cont'd.			*Feet.*		
Section 19 mine, No. 6 seam	Nelsonville	W. B. Brooks & Son	12,520		Bituminous, open-burning	Northern Ohio and northwest.
Carbondale mine, No. 6 seam	Carbondale	McClintock & Smith	63,000	3¾	Bituminous, white ash, open-burning.	Chillicothe and Cincinnati.
Laurel Hill mine, No. 6 seam	Brettland	Jas. O. Guild	24,591	6	Bituminous	Columbus, Cleveland, Toledo, Dayton, and Springfield.
Nelsonville C. and Coke Co.'s mine, No. 7 seam.	Buchtel	Nelsonville Coal and Coke Co.	3,705	6	Bituminous, coking or cementing.	Northern and central Ohio and northwest.
	Nelsonville	J. W. Crain & Co	1,600		Bituminous	Springfield, Ohio.
	do	E. C. Washburn	1,200		do	Nelsonville, Ohio.
	do	Rasser & Conkner	1,000		do	Do.
	do	Matthew Butt	1,600		do	Do.
	BELMONT COUNTY.					
Pittsburgh mine, No. 8 seam	Bellaire	Beckershausen & Sterritt.	26,000	6½	Bituminous	Parkersburgh, Ohio river steamboats, and Bellaire and L. W. R. R.
Hellings mine	Martin's Ferry	Henry Hellings	9,600	5½	do	Martin's Ferry.
Kidd mine, No. 8 seam	Quincy	John Kidd	20,000	5¾	Bituminous, cementing	Balt. and Ohio R. R. Co.
Bernard mine, No. 6 seam	Bellaire	W. G. Bernard	7,000	5½	Bituminous	Bellaire and river trade.
Wegee mine, No. 6 seam	Wegee	P. Shover	12,288	5¾	do	Farmers and mills between Wheeling and Parkersburgh, West Va.
Union mine, Pittsburgh seam	Dillie's bottom	T. Davis & Son	14,217	5¾	Bituminous, soft; iron and steel.	Ohio river points from Moundsville to Parkersburgh, West Va.
Rainey Bank mine, No. 8 seam.	Rainey's switch	Rainey Bank C. Co	100,000	5½	Bituminous, cementing	Cleveland.
Franklin mine, Wheeling or Pittsburgh seam.	Stewartsville	Stewart & Mehan	18,000	5¾	Bituminous, coking	B. and O. R. R.
Barnesville mine, Nos. 8 and 8 C seams.	Barnesville	C. Dawson	5,000	9	Bituminous	Local.
Belmont mine, Wheeling seam	Bellaire	Belmont Coal Co	65,443	5½	do	Points between mine and Louisville, Ky., and home.
	Near Bellaire	Wm. Davie & Bro	2,400		do	B. and O. R. R.
	do	Jos. Gallaher	2,000		do	Local market.
	do	C C. & J. Kelly	1,700		do	Bellaire, Ohio.
	do	Wm. Alton	1,680		do	Do.
	do	I. C. Henry	3,400		do	Do.
	do	J. S. Sullivan	3,800		do	Do.
	Bellaire and vicinity	Beck & Rankin	1,200		do	River to steamboats.
	do	F. Auschutz	2,000		do	Powhatan and vicinity.
	do	Bonar & Kocher	1,200		do	Do.
	do	I. J. Botts, F. Owens, and others.	1,200		do	Do.
	do	W. V. Wallace	800		do	Local market.
	do	John Lewis	1,600		do	Do.
	Bridgeport and vicinity	B. W. McCormick	6,000		do	West Wheeling, local.
	do	Robert Cruth	2,880		do	Do.
Rhodes mine	do	Mike Lyell	4,750		do	Bridgeport and vicinity.
	do	B. McConnehaugh	6,400		do	Do.
	do	Wilban McConnehaugh	13,000		do	Do.
	do	William Fraser	2,400		do	Do.
		Persons about Saint Clairsville.	4,000		do	Saint Clairsville, Ohio.
		Persons about Flushing.	800		do	Flushing, Ohio.
		Persons about Morristown.	800		do	Morristown, Ohio.
		Persons about Mamocks and Glencoe.	1,000		do	Mamocks and vicinity.
		Persons about Goshen township.	1,200		do	Belmont, Fairmont, etc.
	Bridgeport, Martin's Ferry, etc.	R. Heatherington	3,000		do	Bridgeport and local.
	do	H. Kinlein	6,300		do	Do.
	do	Carl Allen	2,400		do	Do.
	do	A. D. Newland	2,836		do	Martin's Ferry.
	do	William Brooks	6,000		do	Do.
	do	H. Deal and others	6,500		do	Glen's Run and vicinity.
	Bellaire and others	A. Keyler	480		do	Bellaire, Ohio.
	do	R. Haslep	2,000		do	Do.
	do	J. Haffman	1,953		do	Do.
	do	Mrs. Fowler and others	3,000		do	Badgersburgh and vicinity.
		Persons in Mead twp	800		do	Local market.
		Persons in Somerset township.	1,000		do	Do.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BELMONT CO.—cont'd.			*Feet.*		
		Simeon Merrill	3,520		Bituminous	Infirmary and country.
	Bellaire	Estate of E. G. Morgan	11,100		do	Bellaire, Ohio.
	do	Jas. Rufer	1,500		do	Do.
	Pultney township	Wilson S. Dailey	3,600		do	Saint Clairsville.
	CARROLL COUNTY.					
Empire mine	Dell Roy	Empire Coal Company	1,367	5	Bituminous, soft, white ash	Canton and Cleveland.
Connotton Valley mine, No. 6 seam.	do	Connotton Valley Coal Company.	970	5¼	Bituminous	Canton, Akron, and Cleveland.
		D. O. Rutan	1,120		Bituminous, cementing	Carrollton, Ohio.
		J. Huston	800		do	Do.
		John Moody	1,600		Bituminous	Do.
		Wm. Brann	800		do	Neighborhood.
		Jas. C. Price	800		do	Do.
		Sam'l Baker	880		do	Do.
		Sam'l Allen	450		do	Do.
		Levi Hunt	500		do	Do.
		Wm. Benedum	490		do	Do.
		Asbury Harsh and others.	650		do	Do.
		Several farmers	600		do	Do.
		Jackson W. Allen	450		do	Do.
	COLUMBIANA COUNTY.					
Graffton Iron Co.'s mine	Leetonia	Graffton Iron Co	26,253	2½	Bituminous, coking	Only at furnace.
Maple Hill mine, No. 6 seam	Teegardin	Maple Hill Co	23,526	4	Bituminous, open-burning	Cleveland and points along line of N. Y., P., and O. R. R.
Shelton mine, No. 6 seam	do	Wm. Barrett	3,000	6	do	Cleveland, Ohio.
Rock Hill mine, No. 3 seam	Robbins station	P. C. Maurer & Co	9,895	3½	Bituminous, soft	Cleveland and Niles, Ohio.
Columbiana C. Co.'s mine, Salineville, Big, and Strip seams.	Salineville	Columbiana C. Co	44,707	9	Bituminous, open-burning and cementing, white ash.	Cleveland, via C. and P. R. R.
Diamond Valley Coal Co.'s mine, Salineville Strip seam.	do	Diamond Valley C. Co.	2,333	3	Bituminous, cementing, low in sulphur, white ash.	C. and P. R. R.
New Lisbon Salt Co.'s mine, No. 5 seam.		Robert Eells	4,512	3	Bituminous, open-burning	New Lisbon, Ohio, largely at owners' salt-works.
Prospect Hill mine, No. 7 and No. 7 A seams.	East Palestine	Filer & Lawton	20,112	7	Bituminous, cementing, gas	Cleveland, New Castle, Penna., Youngstown, local trade.
State Line mine, No. 7 and No. 7 A seams.	do	State Line C. Co	101,800	6 1/12	Bituminous, low in sulphur, cementing, white and reddish ash.	Pitts., Fort Wayne and Chicago R. R.
Shaft Coal Co.'s mine, Salineville Big seam.	Salineville	Ohio and Penna. C. Co.	16,110	5½	Bituminous, moderately cementing.	Cleveland.
Hayes mine, Salineville Big seam.	do	do	43,718	5	do	Do.
Jones mine, Salineville Big seam.	do	do	53,520	5	do	Do.
Conrad mine, Salineville Big seam.	do	do	13,998	5½	do	Do.
Cherry Valley Iron Works' mine.	Leetonia	Cherry Valley I. Works	72,996	2½	Bituminous, soft	Co.'s blast-furnaces and rolling-mill.
Crannage & Anderson mine, Salineville Strip seam.	Salineville	Manufacturer's C. Co	17,000	3	Bituminous, moderately cementing, white ash.	
Farmer mine, Salineville Big seam.	do	do	30,000	5½	Bituminous, moderately cementing.	Cleveland.
	Unity township	Samuel Sheets	480		Bituminous	Palestine and surrounding country.
	do	Jos. Davis	300		do	Unity township.
	do	Samuel Wilhelm	280		do	Do.
	do	—— Hizey	200		do	Do.
		A. J. Cowan	640		do	Neighborhood.
		Syme & Henry	1,832		do	Do.
		Henry Mounts	920		do	Do.
		Battin & Pettit	1,000		do	Do.
		W. B. Stout	960		do	Do.
		A. Armstrong	1,500		do	Cleveland, Ohio.
		J. R. Donley	1,440		Bituminous, cementing	New Lisbon, Ohio.
		Minor & Co	900		Bituminous	Do.
		Jacob Forker	480		do	Neighborhood.
		William Ramsey	400		do	Do.
		William Powell	1,600		do	Do.
		Nathan Stanley	400		do	Do.
		Pettet & Shreve	480		do	Do.
		Washington Bros	500		do	Do.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	COLUMBIANA COUNTY—continued.			*Feet.*		
		Four farmers	500		Bituminous	Neighborhood.
		Six farmers	800		do	Do.
		Isaac Warwick	400		do	Do.
		David Walker	400		do	Do.
		Walter Barr	480		do	Do.
		Jos. Ritchie and others	500		do	Do.
		K. Thomas Temple	400		do	Do.
		David Kelley	450		do	Do.
		H. Nicholson	500		do	Do.
		George Jeffrey	480		do	Do.
		James Murphy	600		do	Do.
	Knox township	Stanley & Co	1,000	3	do	Georgetown, Ohio.
	do	Gideon Stanley	1,000	2	do	Do.
	do	Jos. J. Shrue	400	3	do	Home.
	do	Ruben Sheegan	900	3	do	Do.
	Elk Run township	Thomas Stephenson	8,000	3	do	Do.
	Wellsville	D. Hibbits	200		do	Wellsville.
	do	R. M. Josephs	300	4	do	Do.
	do	J. McCollough	500	4	do	Do.
	COSHOCTON COUNTY.					
Hay mine, No. 6 seam	Coshocton	William G. Hay	4,000	4	Bituminous, moderately cementing.	Coshocton and vicinity.
Beech Hollow mine, No. 6 seam.	do	Prosser & Cassingham	20,000	3½	Bituminous, moderately cementing, purple ash.	Newark and line of P., C. and St. L. R. R.
Coalport mine, No. 6 seam	Franklin station	S. Barnes & Co	15,500	3¾	Bituminous, moderately cementing.	Do.
Home mine, No. 6 seam	Coshocton	G. W. Ricketts	11,664	3½	Bituminous, moderately cemementing, purple ash.	Newark, Columbus, Springfield, and Mount Vernon.
Union Coal and Mining Co.'s mine, No. 6 seam.	do	Union Coal and Mining Co.	18,000	4	do	Line of P. C. and St. L. R. R., Newark, Columbus, and Richmond, Indiana.
	Tuscarawas and Jackson townships.	William R. Hall	1,400		Bituminous	Coshocton.
	do	George Randle	600		do	Roscoe and vicinity.
	do	William G. Moffitt	1,080		do	Do.
	do	Williams & De Gong	2,000		do	Wichsville and Dennison.
	Franklin township	George Barclay	640		Bituminous, cementing	Neighborhood.
	do	David Davis	2,000		do	Newark and Ohio canal.
		James Fitch	600		Bituminous	
		William Poland	400		do	
		Edw. Powell	440		do	
		Wilson & McGarrity	942		do	
	Jackson township	Ira Bell	1,250	3½	do	Surrounding country.
	do	Edw. Prosser	3,500	4	do	Newark.
	do	Jos. Stubbs	1,200	4	do	Surrounding country.
	do	Jas. Passmore	500	4	do	Do.
	Coshocton	Jos. Robeson	1,500	4	do	Coshocton.
	GALLIA COUNTY.					
Cheshire mine, Pittsburgh seam.	Cheshire	Chas. A. Card	8,539	4	Bituminous, open-burning, white ash.	Gallipolis, Ohio, and other points along Ohio river, in Ohio and W. Va.
Small mine	Bush's Mill	Chas. R. Small	2,000	3½	Bituminous, open-burning	Ohio river steamboats.
	Centerville	Wm. S Morgan	400		Bituminous	Centerville, Ohio.
	Kygerville	Asel Ysel	600		do	Neighborhood.
	Cheshire	Geo. Ritz	810		do	Do.
	Addison township	Jos. Rife	600		do	Addison township.
	do	John Shaber	400		do	Do.
	GUERNSEY COUNTY.					
Cambridge C. Co.'s mine	Cambridge	Cambridge C. Co	42,000	5½	Bituminous, free-burning	B. and O. R. R. Co., Can. Southern and Mich. Cen. R. R., local trade in Ind., Mich., and Northern Ohio.
Scott's Salt Mfg. and Min. Co.	Danford	Scott's Salt Mfg. and Min. Co.	40,000	5½	Bituminous	B. and O. R. R. Co., and Mich. Central R. R., and lake trade.
Guernsey Coal Co.'s mine, No. 7 seam.	Cambridge	Guernsey Coal Co	8,000	5½	Bituminous, slightly cementing, rather soft.	Balt. and O. and Northwestern R. R.
Nicholson mine, No. 7 seam	do	Ohio Coal Co	48,000	6	Bituminous	Cleveland, Marietta, and Mansfield.
Shaft mine	Byesville	Manufacturers' C. Co	16,600	5½	do	Cleveland.
		Thos. Ford and others	1,200	[illegible]	do	Middletown, Ohio.
		D. Mc. Peak and others	800		do	Antrim and vicinity.
		J. W. Secrist and others	800		do	Point Pleasant.
	Munroe township	Jas. Giles	250	2½	do	New Birmingham, Ohio.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	HARRISON COUNTY.			*Feet.*		
	German township	Samuel Mull	600		Bituminous	
	Franklin township	McMillen & Bro	2,000		do	Deersville.
		Jas. Kerr	800	4½	do	Cadiz, Ohio.
		J. H. Fare	1,000	4½	do	Do.
		M. S. Jameson	1,600	4½	do	Do.
	Rumley township.	John Lowmiller	800		do	Rumley, township.
	do	Isaac Stewart	1,200		do	Do.
	Monroe township	Abraham Weyant	400	4	do	Bowerston township.
	do	Harrison Mining Co	12,000	4	do	Columbus and Detroit.
	HOCKING COUNTY.					
Gore mine	Gore	Thomas Iron Works	42,987	7½	Bituminous, open-burning, white ash, iron manufacturing.	Exclusively for iron-works, Gore furnace, and Winona.
Carbon Hill mine, No. 6 seam	Carbon Hill	J. H. Somers	70,000	7½	Bituminous, open-burning	Northern and central Ohio and northwest.
Lee Furnace mine, No. 6 seam.	Mowry	Hocking Iron Co	7,000	7	Bituminous, open-burning, iron manufacturing.	Exclusively in furnace of company.
Section 19 mine, No. 6 seam	Nelsonville	W. B. Brooks & Son	112,683	6	Bituminous, open-burning	Northern Ohio and northwest.
Craft's Iron Co.'s mine, No. 6 seam.	Greendale		15,200	8	Bituminous, open-burning, blast furnaces.	Exclusively at furnace.
Black Diamond mine, No. 6 seam.	Haydenville	P. Hayden	83,000	5½	Bituminous, open-burning, white ash.	Columbus, Dayton, Springfield, Xenia-Del., Toledo, Fostoria, Fort Wayne, Inda, Belle Fountaine, Marion, Mount Vernon, Circleville, Chilicothe, Athens, Hillsborough, and Lynchburgh.
	Washington township	Thomas Harris	300		Bituminous	Neighborhood.
	HOLMES COUNTY.					
Mayers mine, No. 6 seam	Millersburgh	Bowen Bros	9,613	4	Bituminous, open-burning	Mount Vernon, Danville, Napoleon, and Westerville.
		Henry Ablett	450		Bituminous	Millersburgh, Ohio.
		John Horn	400		do	Do.
		Valentine Hershberger	400		do	Neighborhood.
	Prairie township	George Chambard	700	1½	do	Home.
	Salt Creek township	John Ewing	800		do	Fredericksburgh, Ohio.
	do	John F. Armstrong	600		do	Do.
	JACKSON COUNTY.					
Eliza Furnace mine, Wellston seam.	Wellston	H. S. Bundy	2,500	4½	Bituminous, open-burning, white ash, iron manufacting.	Cincinnati and Dayton, Ohio.
Huron mine, No. 1 seam	Jackson	Huron Iron Company	12,000	3½	Bituminous, white ash, low in sulphur, iron manufacturing.	Own furnace and employés.
Milton Furnace and C. Co.'s mine, Wellston seam.	Wellston	Milton Furnace and Coal Company.	38,000	4	Bituminous, open-burning, iron manufacturing.	Mostly own furnace, rest to Scioto-ville.
Martin mine, Jackson Hill seam.	Coalton	John P. Martin	5,000	3	Bituminous, open-burning, white ash.	Dayton and Springfield, Ohio.
Wilson mine, Jackson Hill seam.	do	J. H. Wilson & Son	13,500	3	do	Dayton, Springfield, Toledo, and Sandusky.
Jones & Morgan mine, Jackson Hill seam.	do	Jones & Morgan	7,930	3	Bituminous, white ash, open-burning.	Dayton and Chillicothe, Ohio.
Scott, Mohler & Co. mine, Jackson Hill seam.	do	Scott, Mohler & Co	8,000	3½	do	Dayton, Xenia, and Washington, Ohio.
Carr mine, Jackson Hill seam.	Jackson	I. S. Carr	3,000	2 7/12	do	Dayton, Springfield, and Sandusky, Ohio.
McKitterick mine, Jackson Hill seam.	do	J. J. McKitterick	4,000	2⅝	Bituminous, white ash, open-burning, block.	Dayton and Springfield, Ohio.
Newport mine, Jackson Hill seam.	do	James Newport	3,000	2¾	Bituminous, white ash, open-burning.	Line of Springfield Southern R. R.
Miller & Co. mine, No. 1 seam.	do	W. N. Miller & Co	2,400	3½	Bituminous, white ash, open burning, iron manufacturing.	Jackson, Ohio.
Kyle, Shotts & Co. mine, No. 1 seam.	do	Kyle, Shotts & Co	5,000	4	do	Jackson and Springfield, Ohio.
Price Bro.'s mine, Jackson Hill seam.	do	Price Bros	8,000	2½	Bituminous, open-burning	Dayton, Springfield, Sandusky, Tiffin, and Toledo, Ohio.
Globe Iron Co.'s mine, No. 1 seam.	do	Globe Iron Co	24,000	4	Bituminous, open-burning, iron manufacturing.	Own furnace.
Tropic mine, No. 1 seam	do	Tropic Iron Co	4,648	4	do	Do.
Wellston C. and I. Co.'s mine, Wellston seam.	Wellston	Wellston C. and I. Co	20,555	4	Bituminous, open-burning, white ash, iron manufacturing.	Own furnace, Cincinnati, Hillsborough, Greenfield, and Dayton.
Star Furnace Co.'s mine, No. 1 seam.	Jackson	Star Furnace Co	2,815	3½	Bituminous, open-burning, white ash, low in sulphur, iron working.	Own use.
Oak Hill F. B. and C. Co.'s mine, No. 5 seam.	Oak Hill	O. A. F. B. and C. Co	2,880	3	Bituminous, open-burning, purple ash.	Oak Hill, Ohio, principally used by fire brick co.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	JACKSON CO.—cont'd.			*Feet.*		
Darling mine, Jackson Hill seam.	Coalton	Pimlott & Hall	11,000	3½	Bituminous, block, open-burning.	Dayton and Springfield, Ohio.
Callayhan & Galliland mine, No. 1 seam.	Jackson	Callayhan & Galliland	4,800	3¼	Bituminous, white ash, open-burning, iron working.	Springfield and Washington, Ohio.
Darling mine	Coalton	Pimlott & Hall	12,000	3½	Bituminous	Springfield, Dayton, Toledo, and Sandusky.
Jackson Co.'s cannel mine, Jackson Hill seam.	do	Cooper & Scott	2,440	3	Bituminous and cannel, open-burning.	Dayton and Chillicothe, Ohio.
Ætna Fire Brick Co.'s mine, No. 5 seam.	Oak Hill	Ætna Fire Brick Co	1,700	3½	Bituminous, open-burning	Oak Hill, Ohio.
Globe mine	Jackson	Globe Iron Co	18,000	3½	Bituminous	Own Fulton furnace.
		Jefferson Furnace Co	340		do	Furnace families.
		E. J. Jankins	400		do	Oak Hill, Ohio.
		John Thomas	840		do	Do.
		Clare, Didnit & Co	480		do	Furnace families.
		Keystone Co	600		do	Do.
		John Cobb	440		do	Cincinnati, Ohio.
		Lewis Gibson	600		do	Jackson, Ohio.
		Richard Bartlett	1,200		do	Do.
		Thompson & Moore	4,000		do	M. and C. R. R line.
		William Chambers	400		do	Jackson, Ohio.
		Henry Vanfassen	1,200		do	Do.
		Jefferson Howe	480		do	Do.
	Monroe furnace	Union Iron Co	520		do	Furnace families.
		Cornelia furnace	400		do	Do.
	JEFFERSON COUNTY.					
High shaft, No. 6 seam	Steubenville	Steubenville C. and Min. Co.	50,076	3⅝	Bituminous, soft, coking, mfg. iron and sharp-edged tools, steam and blacksmithing.	Steubenville City, P., C. and St. L. R. R., Columbus, Dayton, and Urbana.
Walnut Hill mine	Yorkville	O. and P. C. Co. and S. M. Bloomer.	78,000	5	Bituminous	Cleveland, Bellaire, Wellsville, Fort Wayne R. R.
Jefferson C. & I. Co., No. 6 seam.	Steubenville	Jefferson C. and I. Co	37,030	4	Bituminous, coking	
Groff mine, No. 7 seam	Linton	W. W. Nessly	12,672	4	Bituminous	Cleveland.
Steubenville Furnace and I. Co.'s mine, No. 6 seam.	Steubenville	Steubenville Fce. and I. Co.	28,955	3½	Bituminous, coking	Furnace.
Diamond mine, No. 6 seam	Linton	S. N and W. G. McCullough.	16,702	6⅝	Bituminous	Local.
La Grange mine	Phillipsburgh	Alex. Gilchrist	4,000	4½	do	Steamboat trade.
Rush Run mine, Steubenville seam.	Rush run	Rush Run Shaft C. Co.	7,000	4 11/12	do	Cleveland, Ohio.
Jefferson mine, Steubenville seam.	Steubenville	Jefferson Iron Works.	64,318	3⅜	Bituminous, soft	Jefferson Iron Works.
Hammondsville mine, Hammondsville strip seam.	Hammondsville	W. H. Wallace & Sons.	12,275	2½	Bituminous, free from pyrite and slate.	Cleveland.
Junction Iron Co	Mingo junction	Junction Iron Co	10,012		Bituminous	
	Irondale	Isaac Thomas	700		do	Local and on R. R.
	Springfield township	Cicero Davidson	550	5	do	Local trade.
	do	Levi Miller	500	5	do	Do.
	Wayne township	Harrison H. Albaugh	680		do	Wayne twp., Jefferson Co.
	do	Henry M. Ralston	600		do	Do.
	LAWRENCE COUNTY.					
Hanging Rock mine, No. 5 seam.	New Castle	Means, Kyle & Co	56,400	3½	Bituminous	Hanging Rock, Ohio, steamboats, also along Ohio river as far as Louisville, Ky.
Sheridan Min. Co., No. 6 seam.	Sheridon C. Works	Sheridon Min. Co	24,000	3½	do	Cincinnati, Louisville, and Portsmouth, via Ohio river.
Washington furnace mine, No. 6 seam.	Washington furnace	Union Iron Co	12,099	3	do	Own furnace.
		W. C. Hutchins & Co	1,000		do	Waterloo and vicinity.
		Geo. W. Collins	500		do	Hanging Rock and vicinity.
		T. Caldwell	400		do	Do.
		T. J. Neal and others	280		do	Vicinity of Gallia Co.
		J. M. Kelley	2,440		do	West Ironton.
		I. H. McGee	480		do	Rock Camp.
		Wm. Wilson	1,520		do	Marion.
		A. Massey	800		do	Oak Ridge.
		Thos. Tagg and others	1,000		do	Greasy Ridge.
		I. M. Sloan	800		do	Arabia.
	Ironton	Wm. Herdman	4,527		do	Ironton, Ohio.
	do	John A. Blackwell	1,355		do	Do.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LAWRENCE CO.—cont'd.			*Feet.*		
	Ironton	S. Klein	1,095		Bituminous	Ironton, Ohio.
	do	T. G. Atkins	506		do	Do.
	do	S. C. Simpson	1,312		do	Do.
	do	A. Francisco	1,045		do	Do.
	Near Ironton	I. Gillin	2,200		do	Do.
	do	C. T. M. Kemp	2,200		do	Do.
	do	Mr. Lawless	1,200		do	Do.
	do	G. Thompson	470		do	Do.
	do	Geo. May	900		do	Do.
	do	Wm. Kelley	400		do	Do.
	Elizabeth township	Etna Iron Works	2,800		do	Ourselves.
	do	Lawrence Iron M'f'g Co.	1,200		do	R. R. engines.
	do	Means, Kyle & Co	1,200		do	Pine Grove furnace.
	Rome township	Owen Gillett	700		do	Proctorville, Ohio.
	do	Spencer Gillett	750		do	Do.
	MAHONING COUNTY.					
Darrow mine, No. 1 seam	Lowellville	Struther's Iron Co	3,555	3	Bituminous, block	Struther's furnace,
John Henry mine, Mineral Ridge seam.	Ohltown	Homer Baldwin	10,678	3	Bituminous	Cleveland.
Walter mine, Nos. 3 and 4 seams.	Washingtonville	Walter & Co	19,809	6	do	Do.
Buckeye mine, No. 1 seam	Scrip hill	James Neilson	7,814	2¼	do	Youngstown.
Enterprise mine, No. 1 seam	Youngstown	Mahoning Iron Co	1,890	3	Bituminous, open-burning; furnace.	Do.
Foster mine, No. 1 seam	do	Foster Coal Co	48,929	4	Bituminous, block	Western and home.
Kyle mine	Kyle Corners	Kyle Coal Co	50,000	4	do	Youngstown and Cleveland.
Ohltown mine, No. 1 seam	Ohltown	Harris, Maurer & Co	16,780	3	Bituminous, domestic, rolling-mill, and steam.	Niles.
Pennel mine	Austintown	New Lisbon Coal Co	18,000	2–4	Bituminous	Youngstown, Niles, and Cleveland.
Powers mine	Youngstown	A. and W. Powers	38,850	3½	Bituminous, furnaces	Cleveland, Fairport, and Youngstown.
Austin mine, Mineral Ridge seam.	Mineral ridge	Todd, Wells & Co	17,000	3½	Bituminous	Cleveland.
——, Mineral Ridge seam	do	Campbell Coal Co	2,000	4	do	Local trade.
	MEDINA COUNTY.					
Wadsworth C. Co.'s mine, No. 1 seam.	Wadsworth township	Wadsworth Coal Co	56,000	4	Bituminous, open-burning, white ash.	Akron and N. Y., Penn., and O. R. R. Co.
Diamond mine, No. 1 seam	do	Humphrey & Coleman	50,000	4	do	Do.
	MEIGS COUNTY.					
Pomeroy Coal Co.'s mine, No. 8 seam.	Pomeroy	Pomeroy Coal Co	180,266	4¾	Bituminous	Maysville, Ky, Cincinnati, Ohio, Louisville, Ky., Portsmouth and Ripley, Ohio.
Slope mine, first seam	Syracuse	Union Mines Co	5,964	5	do	Towns along Ohio river.
Riverside mine, Pomeroy seam.	Antiquity	Ohio Coal Co	8,000	5⅝	do	Cincinnati and Louisville.
Syracuse Salt and Coal Co.'s mine, Pittsburgh seam.	Syracuse	Syracuse Salt and Coal Co.	53,339	4⅜	do	Steamboats, Cincinnati, and salt furnace.
S. Wyllys Pomeroy's mine, Pomeroy seam.	Pomeroy	S. W. Pomeroy	33,000	5	do	Cincinnati.
Williams mine, Pomeroy seam.	Minersville	John E. Williams	40,656	4⅝	do	Cincinnati and Louisville.
	Pomeroy and vicinity.	M. Ebbersbuch	2,600		do	Pomeroy, Ohio, and vicinity.
	do	Seth Pain	2,000		do	Rutland, Ohio, and vicinity
	do	John Stiff	1,000		do	Vicinity of Middleport.
	do	John Carr	800		do	Do.
	do	R. G. Wells	1,000		do	Paigeville, Ohio.
	Pomeroy and vicinity.	H. S. Holt	400		do	New Lima, Ohio.
	Middleport, Pomeroy, and vicinity.	Jos. Wells	4,000		do	Middleport and vicinity.
	do	R. H. Hayman	3,000		do	Do.
	do	J. G. Stewart	2,000		do	Do.
	do	William Snowdon	2,000		do	Do.
	do	George Russell	2,000		do	Do.
	do	Thomas King	1,200		do	Do.
	Pomeroy and vicinity.	N. Watson	800		do	Middleport and vicinity of mine.
	do	I. Bradfield	800		do	Do.
	do	P. Hysell	2,000		do	Do.
	do	James Donaldson	2,400		do	Pomeroy and vicinity of mine.
	do	S. F. Moore	1,200		do	Do.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MEIGS CO.—cont'd.			*Feet.*		
	Pomeroy and vicinity.	John Carlton and others.	2,400		Bituminous	Pomeroy and vicinity of Chester.
	do	J. M. Strider	800		do	Pomeroy and mill.
	do	Montague estate	400		do	Pomeroy and vicinity.
	do	Montgomery & Hawk.	800		do	Bungtown and mill.
	do	Thomas Bradford and others.	2,000		do	Rock Spring and vicinity.
	do	C. Haber	2,400		do	Middleport and vicinity of mine.
	MONROE COUNTY.					
	Stafford township	Persons in Stafford	1,600		Bituminous	Local.
	Perry township	Kincaid & Bottenfield.	800		do	Antioch, Ohio.
	Center township	Aaron Morris	60		do	Woodsfield, Ohio.
	do	John Friax	400		do	Do.
	do	Samuel Smith	400		do	Do.
	do	Robert McCanemore	50		do	Do.
	MORGAN COUNTY.					
		William Whipple	1,200		Bituminous	McConnelsville, Ohio.
		Martin, Kinnard & Co.	750		Bituminous	Neighborhood.
		Nathan Woodyard	800		do	Do.
		Jno. Barnes	480		do	Windsor, Ohio.
		Martin Spurier	450		do	Neighborhood.
	MUSKINGUM COUNTY.					
Orvins mine, No. 6 seam	Orvins' landing	Jas. Orvins	10,000	3½	Bituminous, cementing	McConnelsville and intermediate points to Muskingum river.
Seelover mine	Zanesville	W. H. Seelover	1,664	3	Bituminous, open-burning	Zanesville.
Bridwell mine	do	Jas. Bridwell	2,080	3	do	Do.
Monitor mine	do	Hiram Cowell	2,080	8	do	Do.
Muskingum Valley mine, No. 6 seam.	Roseville	Geo. Vlereborne	10,000	3½	do	Cincinnati, Circleville, and Washington, Ohio.
Peacock mine, No. 6 seam	Gilbert	D. Matthews & Co	10,000	8	Bituminous, cementing	Newark, Mt. Vernon, Cleveland, Columbus, Dayton, and points in that range of country.
Del Carbo mine, No. 6 seam	Roseville	Consolidated C. & M. Co.	22,000	4½	Bituminous, open-burning	Zanesville, Cincinnati, Columbus, Washington, and Circleville, Ohio.
	Coal mines	Geo. E. Langan	1,600		Bituminous	Zanesville.
	do	Lewis Harper	4,056		do	Do.
	do	Eli Lucas	2,028		do	Do.
	do	J. W. Walls	1,480		do	Do.
	do	Z. Reed	4,000		do	Do.
	do	J. Morgan	3,000		do	Do.
	do	Henry Greiner	4,000		do	Do.
	do	E. Harper	6,280		do	Do.
	do	J. L. Taylor	3,348		do	Do.
	do	Isaac Melvin	1,600		do	Do.
	do	P. G. McCormick	2,418		do	Do.
	do	John Richards	1,800		do	Do.
	Madison township	J. Varley	1,800		do	Dresden and surrounding country.
	do	Henry McCain	1,200		do	Do.
	do	Jas. Little	1,000		do	Do.
	Zanesville corporation.	P. Stockdale	800		do	Zanesville.
	do	Orrin Ballou	2,400		do	Do.
	Jackson township	L. B. Goff & Bro. and George Nethers.	200		do	Frazeysburgh and Irville.
	Hopewell township	Henry Dick	1,453		do	Western part of Muskingum county and eastern townships of Licking county.
	do	Jos. Porter	530		do	Do.
	do	Samuel Porter	600		do	Do.
	do	George Porter	300		do	Do.
	Coal mines	J. Stevens	1,800		Bituminous, cementing	Salt furnace and Neighborhood.
	do	Charles Stone	640		do	McConnellsville, Ohio.
	do	G. Scarvill	1,000		do	Do.
	do	S. Guttini	2,000		do	Salt furnace.
	do	H. Blundy	3,600		do	Do.
	do	J. S. Marcellus	800		Bituminous, open-burning	Zanesville, Ohio.
	do	Henry Horton	4,800		Bituminous	Do.
	do	G. Wheeler	5,200		do	Do.
	do	J. J. Granger	1,600		do	Do

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MUSKINGUM CO.—cont'd.			Feet.		
	Coal mines	Thomas Potts	3,000		Bituminous	Zanesville, Ohio.
	do	R. White	2,663		do	Do.
	do	George Trout	800		do	McConnellsville, Ohio.
		Isaac Crofft	800		do	Newtonville, Ohio.
		Andrew Goodheart	800		do	Neighborhood.
		Lett Bros	600		do	Do.
		Harrison Roberts	420		do	Do.
	Harrison township	James Robinson	697		do	McConnellsville and Taylorville.
	Muskingum township	Beattie Johnston	400		do	Local.
	do	Ewing Fletcher	400		do	Do.
	NOBLE COUNTY.					
Macksburgh mine, Pittsburgh seam.	Macksburg	Ohio Coal Co	10,000		Bituminous, somewhat cementing.	Line of C. and M. R. R
		Parties in Beaver twp.	1,200		Bituminous	Beaver township.
		Parties in Brookfield township.	800		do	Brookfield township.
		Parties in Buffalo twp.	700		do	Buffalo township
		Parties in Center twp.	720		do	Center township.
		Parties in Elk twp	2,040		do	Elk township.
		Parties in Enoch twp.	600		do	Enoch township.
		Parties in Jefferson township.	1,000		do	Jefferson township.
		Parties in Marion twp.	640		do	Marion township.
		Parties in Seneca twp.	500		do	Seneca township.
		Parties in haron twp.	160		do	Sharon township.
		Various parties	560		do	Stock township.
		do	1,000		do	Olive township.
		do	1,000		do	Caldwell township.
		do	600		do	Jackson township.
	Beaver township	William Lashley	600	4¾	do	Kennonsburgh and vicinity.
	Marion township	John H. Shenkland	800		do	Summerfield, Ohio.
	do	O'Neil Horton	640		do	Do.
	Olive township	Toler Bros	400		do	Caldwell, Ohio.
	do	Ezra Davis	450		do	Do.
	do	William Cunningham	350		do	Caldwell and vicinity.
	PERRY COUNTY.					
Consolidated C. and Min. Co., No. 6 seam.	New Straitsville	Consol. C. and Min. Co.	67,964	11	Bituminous	Central Ohio and Ohio lake ports.
Tague mine, Nelsonville seam.	McCluney	M. & P. Tague	16,862	3½	Bituminous, open-burning	Points on Cincinnati and Muskingum Valley R. R.
Tunnel Hill mine, Nelsonville seam.	New Lexington	Lyonsdale Coal Co	3,343	3½	do	Do.
No. 3 mine, No. 6 seam	Rendville	Ohio Central C. Co	15,000	8	Bituminous, open-burning, iron-making.	
Troy mine, No. 6 seam	New Straitsville	Thomas C. and I. Co.	108,569	10	do	Cleveland, Toledo, Detroit, W. and N.W.
XX mine, No. 6 seam	Shawnee	Sandusky and Shawnee C. and I. Co.	6,671	8	Bituminous, white-ash, open-burning; iron-making.	Own furnace exclusively.
Davies mine, No. 6 seam	Bristol station	Daniel E. Davies	3,120	3	Bituminous, open-burning	Along B. and O R. R.
Jones mine, No. 6 seam	McCluney	S. & J. Jones	7,200	3½	do	Along Cin. and Muskingum Val. R. R.
Sunday Creek mine, No. 6 seam.	Rendville	Sunday Creek C. Co	5,222	8½	do	Toledo, Cleveland and Columbus, by Ohio Cen. R. R.
Straitsville C. M. Co.'s mine, No. 6 seam.	New Straitsville	Straitsville Central Min. Co.	121,072	10	Bituminous, open-burning white-ash.	Columbus, Cleveland, Dayton, Springfield, Sandusky, Detroit, etc.
Baird Iron Co.'s mine, No. 6 seam.	Baird Iron Works	Baird Iron Co	15,749	10	Bituminous, dry-burning	Own furnace.
Brilliant mine, No. 6 seam	McCuneville	J. E. Payne	5,000	3½	Bituminous, open-burning	Along B. & O. R. R. and Cen. O. R. R.
N. Y. and Straitsville C. and I. Co.'s mine, No. 6 seam.	Shawnee	N. Y. and Straitsville C. and I. Co.	100,000	8	Bituminous, open-burning; iron manufacturing.	Vilas furnace, Toledo, Detroit, north and northwest.
Straitsville C. Co.'s mine, No. 6 seam.	New Straitsville	Straitsville C. Co	77,646	9	do	Cleveland, Detroit, Dayton, Toledo, etc.
Furnace C. Co.'s mine, No. 6 seam.	Shawnee	Jas. G. Manly	42,179	9	Bituminous, open-burning; smelting iron.	Zanesville and Columbus, Ohio.
Card & Upson C. Co.'s mine, Nelsonville seam.	do	Card & Upson C. Co	47,879	9½	Bituminous, open-burning	Lake trade north and northwest, via B. and O. R. R.
Straitsville Min. Co., No. 6 seam.	New Straitsville	J. S. Doe & Co	92,640	8	do	Ohio, Mich., Cana., and parts of Wis., Ind., and Ill.
Shawnee Valley C. and I. Co.'s mine, No. 6 seam.	Shawnee	Shawnee Valley C. and I. Co.	64,163	9–12	Bituminous, hard, dry	Toledo, Ohio, Detroit, Mich., Chi., Ill. and points on lake Erie.
Chicago mine, No. 6 seam	New Straitsville	W. P. Rend & Co	51,872	8	Bituminous, open-burning white-ash.	Chicago, Ill., and Columbus, Ohio.
Sunday Creek mine, No. 6 seam	Rendville	do	25,000	7	Bituminous, very pure	Chicago, Cleveland, and Columbus.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	PERRY CO.—cont'd.			*Feet.*		
Straitsville Cannel C. Co.'s mine, Nelsonville seam.	Shawhee	M. A. Corcoran	33,772	12	Bituminous, open-burning	Northwest, Columbus, Chicago, Detroit, etc., Toledo, and Sandusky.
	Coal-mining	S. S. Avery	1,251		Bituminous	New Lexington, Ohio.
	do	Isaac Denny	1,000		do	Do.
	do	Thomas Green	800		do	Northern Perry county, Ohio.
	PORTAGE COUNTY.					
Wilson mine	Palmyra	W. B. Wilson	10,900	4	Bituminous block, open-burning, splint.	Cleveland and Chicago.
Black Diamond mine, No. 1 seam.	do	P. L. Kimberly	16,380	3½	Bituminous, open-burning	Do.
	Atwater township	David Johns	500		Bituminous	Local.
	SCIOTO COUNTY.					
Webster Fire-Brick Co.'s mine, No. 3 seam.	Webster	Webster Fire-Brick and C. Co.	2,200	1 5/12	Bituminous, open-burning, purple-ash.	Webster Fire-Brick Works.
	Bloom township	Edw. Kühner	320		Cannel	Portsmouth, Ohio.
	do	W. L. Cook	560		do	New Vienna, Ohio.
	Vernon township	John Campbell	285		Bituminous	Furnace families.
	STARK COUNTY.					
Wamington mine, Massillon seam.	Massillon	Wamington C. Co	24,150	4	Bituminous	Lake ports.
Hadley mine, No. 4 seam	North Industry	Brown & Hadley	7,500	3½	Bituminous, open-burning	Canton, Ohio, and neighborhood.
Welty mine, No. 3 seam	Canton	Abraham Welty	3,000	3⅝	do	Canton, Ohio.
Smith, Borst & Co.'s mine, Limestone seam.	Greentown	Smith, Borst & Co	2,260	4	do	Line of Valley R. R.
Holwick mine, second seam	Osnaburgh	Frank Bowen	3,696	4½–5	Bituminous, soft, smithing	Canton and Akron, Ohio.
Lawrence mine, No. 1 seam	North Lawrence	Ridgway, Burton & Co	58,000	4½	Bituminous, open-burning, manufacturing of iron.	Cleveland, Toledo, Wooster, Mansfield, Lima, and Ft. Wayne, Ind.
Oak Hill mine, No. 1 seam	Massillon	James Neall & Co	26,000	3½	Bituminous, open-burning, low in sulphur.	Line of P., Ft W. and C. R. R., from Massillon westward to Bourbon, Ind., Toledo, Cleveland, Ann Arbor, Mich., &c.
Willow Bank No. 3 mine, Massillon seam.	Millport	Willow Bank C. Co	21,210	4	Bituminous	Cleveland, via Ohio canal.
Sippo mine, Massillon seam	Massillon	Sippo Coal Co	5,000	4	Bituminous, open-burning	Cleveland.
Massillon City mine, No. 1, seam.	do	Henry Foltz and J. F. Pocock.	32,995	5	Bituminous, open-burning, white ash, low in sulphur.	Cleveland and Massillon.
Grove Coal Co's mine, No. 1 seam.	do	Grove Coal Co	25,134	4	Bituminous; iron making	Cleveland.
Pigeon Run mine, No. 1 seam	Pigeon Run	Massillon and Pigeon Run C. Co.	25,000	5	Bituminous, open-burning, white ash, low in sulphur.	Lake Erie ports, Cleveland and Black river.
Thomas mine, No. 6 seam	Alliance	J. L. Thomas	3,000	2½	Bituminous, cementing	Alliance.
Rhodes mine, Massillon seam	Massillon	Rhodes Coal Co	26,693	4½	Bituminous	Lake ports.
Willow Bank mine, Massillon seam.	do	Willow Bank C. Co	14,282	4½	do	Cleveland, via Ohio canal, lake ports, via Black river and C. T. V, and W. R. R.
McCallum & Poto mine, No. 6 seam.	Limaville	McCallum & Poto	1,626	3 5/12	Bituminous, open-burning	Neighborhood.
Camp Creek mine, No. 1 seam	Pigeon Run	O. Young & Co	18,000	4½	Bituminous, open-burning, white ash.	Lake Erie ports.
		Charles Feiby	480		Bituminous	Canton.
		Harrison Tailor	490		do	Do.
		Schutzner & Hollenstern.	480		do	Do.
		Jesse Miller	400		do	Do.
		Jacob Slemmer	400		do	Do.
		John Kains	400		do	Do.
		Lewis Kemmerle	480		do	Do.
		Jos. Miller	400		do	Do.
		Jacob Bros	480		do	Do.
		Christopher Krider	400		do	Do.
		J. H. Ross	490		do	Waynesburgh.
		Peter Shoenebarger	490		do	Canton.
		Abraham Spoonsellar	475		do	Do.
		Geo. Oyster and others	800		do	Do.
		Judge Frease	400		do	Do.
		J. Oberlin and others	600		do	Do.
		Harbert and others	500		do	Neighborhood.
		Worstler and others	400		do	Do.
		Stainsburg Co	700		do	Do.
		Isaac Smith	500		do	Do.
		Martin Brothers	400		do	Do.
		John Clark	400		do	Do.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	STARK CO.—cont'd.			*Feet.*		
		Infirmary neighborh'd	500		Bituminous	Neighborhood.
	Alliance	A. Dixon	1,000		Bituminous, open-burning	Alliance, Ohio.
	do	Thomas Lowe	1,700		do	Do.
	do	Eli Grant	1,570		do	Do.
	do	Black, Lewis & Reynolds.	700		do	Do.
	do	John P. Ebachardt	720		Bituminous	Canton, Ohio.
		Abraham Clark	2,200		do	Do.
		Peter Newman	2,000		do	Do.
		Albert Smith	3,120		do	Neighborhood.
		Andrew Monery	1,880		do	Canton, Ohio.
		John Lictenwalter	2,000		do	Do.
		John Yohe	960		do	Do.
		David Kinney	1,200		do	Do.
		Kinney Brothers	750		do	Do.
		Moyadore C. Co	700		do	Moyadore, Ohio.
		Clayton Hall	1,200		do	Greentown, Ohio.
		John Sausser	2,000		do	Canton, Ohio.
		J. S. P. Gordon	600		do	Do.
		Fred. Fetzer	1,200		do	Massillon, Ohio.
		Henry Koontz	1,500		do	Do.
		Morgan Owens	3,000		do	Cleveland, Ohio.
		Schrock & Evans	800		do	Canal, Fulton, Ohio.
		J. Lever	500		do	Do.
	Lexington township	David D. Waugh	2,800		do	Alliance, Ohio.
	do	William K. Ellett	800		do	Do.
	do	Charles W. Nolan	800		do	Do.
	Bethlehem township	George Sheplar	400	3	do	Navarre.
	do	Jos. Hare	600	3	do	Do.
	Lawrence township	John Seaver	1,000	4	do	Local trade.
	do	Hower, Simmons & Co.	1,500	3	do	Cleveland, Ohio.
	SUMMIT COUNTY.					
Nimisila mine, No. 1 seam	New Portage	Nimisila Coal Co	25,000	4½	Bituminous, open-burning; iron making.	Cleveland, Ohio, and other towns on lake Erie.
Norton Coal Co.'s mine, No. 1 seam.	Dennison	Norton Coal Co	21,000	4	Bituminous, open-burning, white ash.	N. Y., Penn., and O. R. R. Co.
Summit Bank mine	Springfield	Middlebury C. Co	13,838	4	Bituminous	Cleveland and Akron.
Summit mine, No. 1 seam	Coventry	Summit Mine C. Co	21,570		Bituminous, open-burning	Cleveland.
Brewster mine, No. 1 seam	do	Brewster Coal Co	18,556	4	do	Cleveland and Akron.
Brewster Bros. mine, No. 1 seam.	Middlebury	Brewster Bros. C. Co	9,000	4½	do	Cleveland and neighborhood.
		John Beese	2,500		Bituminous	Neighborhood.
		John Collier	2,000		do	Do.
		Brewster Coal Co	2,000		do	Do.
	TRUMBULL COUNTY.					
Burnett mine, No. 1 seam	Hubbard	Andrew & Hitchcock	86,290	4	Bituminous, block	Home, blast-furnaces, and western trade.
Lovebank mine, No. 1 seam	Hubbard	Andrew & Hitchcock	30,774	4	Bituminous	Western markets and home.
Brookfield mine	Brookfield	Curtis & Boyce	25,623	3	Bituminous, block	Erie, Pa., Erie and Pittsburgh R. R.
Holliday mine, No. 1 seam	Vienna	Holliday Coal Co	65,000	2-4	do	Cleveland, Chicago, Buffalo, and Youngstown.
Hubbard mine	Hubbard	D. H. Williams	2,000	2	do	Hubbard.
Blackberry shaft, Brier Hill seam.	Vienna	Vienna C. and I. Co	39,073	4	do	Cleveland and Buffalo
McCurdy C. Co.'s mine, Brier Hill seam.	Sodom	McCurdy Coal Co	24,351	4	do	Youngstown and Cleveland, Ohio.
New Slope mine, No. 1 seam	Mineral Ridge	Osborn Coal Co	16,000	4½	Bituminous; domestic and for puddling iron.	Niles and Cleveland, Ohio.
No. 8 mine. Brier Hill seam	Coalburgh	Mahoning C. Co	37,189	2-4	Bituminous, block	Youngstown and Cleveland.
No. 3 mine, No. 1 seam	do	do	50,479	2-4	Bituminous, block, dry-burning; furnaces.	Youngstown, Cleveland, Atlantic and Lake Shore R. R., now called N. Y., P. and O. R. R.
Otis or Cleveland mine, No. 1 seam.	Brookfield	Otis Coal Co	47,610	2-4	Bituminous, block; furnaces, mills, and steam.	Cleveland, Canada, Rochester, N. Y., and Chicago. Lake Shore, Atlantic and Great Western R. R.
Brookfield mine, No. 1 seam	do	Brookfield Coal Co	87,075	2-4	Bituminous, open-burning, free from pyrite.	Sharon, Pa., Cleveland, A. and G. W. R. R., now the N. Y., P. and O. R. R.
No. 9 mine, No. 1 seam	Liberty	Mahoning Coal Co	706	4	Bituminous block, dry-burning; iron smelting.	Cleveland and Youngstown.
Shenango mine, No. 1 seam	Hubbard	Shenango Coal Co	40,000	1⅔-4⅔	Bituminous, open-burning, free from pyrite; furnaces.	Erie, Cleveland, Sharon, Youngstown Middlesex, via N. Y., P. and O. R. R., and E. and P. R. R.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	TRUMBULL CO.—cont'd.			*Feet.*		
John Henry mine	Mineral Ridge	Homer Baldwin	10,453		Bituminous, with blackband iron ore.	
Kline mine, Brier Hill seam	Church Hill	Tod Iron Co.	40,000	2–3	Bituminous; iron smelting	Brier Hill furnaces, near Youngstown.
Church Hill mine, No. 1 seam	do	Church Hill C. Co.	90,274	4	Bituminous, block, dry-burning; iron smelting.	Cleveland, Chicago, Canada, N. Y., P. and O. R. R.
Cambria mine, Mineral Ridge seam.	Mineral Ridge	Wm. T. Williams & Co.	27,017	3	Bituminous, with blackband ore.	Cleveland, Niles, and Warren, Ohio.
	Brookfield	Jones & Ferguson	400	3½	Bituminous, block	Youngstown, Ohio.
	Mineral Ridge	Morris Williams	650	4	Bituminous	Local trade.
	do	William Hitchen	650	4	do	Do.
	do	Evans Brothers	125	4	do	Do.
	do	Wm. Phillips & Son	125	4	do	Do.
	do	T. O. Pritchard	340	4	do	Do.
	do	Lewis O. Jenkins	60	4	do	Do.
	TUSCARAWAS COUNTY.					
Wilhelmi mine, No. 5 seam	Canal Dover	C. W. Bodez	6,000	4	Bituminous, moderately cementing.	Sugar Creek Salt-Works.
Goshen Ridge mine, No. 6 seam.	New Philadelphia	Mathias & McFarland	10,000	4½	Bituminous, cementing	Cleveland, and along Ohio canal.
New Phila. Salt Works mine, No. 5 seam.	do	Custer, Scott & Waddington.	2,500	4	do	Salt-works of company and local.
Newcastle mine, No. 6 seam	do	Groff & Dant	6,500	4½	do	Cleveland, and along Ohio canal.
Tubbs & Dunn mine, No. 5 seam.	do	Tubbs & Dunn	5,000	4⅝	Bituminous, slightly cementing.	New Philadelphia.
Glasgow, Port Washington Iron and Coal Co.'s mine, Benton seam.	Glasgow	Glasgow, Port Washington Iron and Coal Co.	3,500	14	do	Own furnace and men.
Andreas mine, No. 6 seam	Wrichsville	John Bruner	6,000	3⅝	Bituminous, cementing	P., C. and St. L. R. R., Cleveland via Tuscarawas Valley R. R.
Newberry mine, No. 5 seam	Mineral Point	C. E. Holden	3,715	4	do	Fire-Clay Works, Mineral Point, and Cleveland, Ohio.
Tunnel mine, No. 5 seam	do	Tuscarawas Coal and Iron Co.	30,000	3½	do	Do.
Block Vein Coal Co.'s mine, No. 5 seam.	do	J. L. Morris	9,000	3	Bituminous, moderately cementing.	Cleveland, via C. and P. R. R.
Cleveland Coal Co.'s mine, Salineville Big seam.	Salineville	Ohio and Pennsylvania Coal Co.	35,874	5½	do	Cleveland.
Tuscarawas Valley Coal Co.'s mine, No. 6 seam.	Pike's Run	Tuscarawas Valley C. Co.	75,436	4⅜	Bituminous, cementing	Northern Ohio and Lake Erie ports.
Mount Carbon mine, No. 6 seam.	Trenton	C. P. Minnick	7,000	3⅝	do	Cleveland by canal.
	Sandy township	J. Byeily	800		Bituminous	
	do	J. L. Birk	1,097		do	
	Franklin township	John Byeily and others	1,120		do	Franklin township.
	do	Robert Ramsay	1,520		do	Do.
	do	Henry Beck	80		do	Do.
	do	George Haas	200		do	Do.
	do	Samuel Swaby	40		do	Do.
	Mill township	Thomas A. Packer	200		do	Uhricksville township.
	Goshen township	J. W. King	2,500		do	New Philadelphia and country.
	do	Thomas Pesker	1,600		do	Do.
	Goshen, Warwick, and Mill townships.	William Hummel	624		Bituminous, open-burning	New Philadelphia, Ohio.
	do	Josiah Dorsey	940		do	Do.
	do	W. R. Jones	2,000		Bituminous, cementing	Cleveland, Ohio.
	Goshen, Warwick, and Mill townships.	Nicholas Hart	8,775		do	Do.
	do	A. Horning	5,600		do	Do.
	do	W. B. Rennie	1,580		do	Uhricksville and Dennison.
	Goshen and Dover townships.	Dover Salt Co.	6,600		Bituminous, open-burning	Own consumption.
	do	Jos. Kranz	1,000		do	Dover, Ohio.
	do	A. Schneider	1,600		do	Do.
	do	J. W. Ferris	1,640		do	New Philadelphia, Ohio.
	do	Thos. Steel	1,320		do	Do.
	do	J. D. McIlraim	1,000		do	Do.
		J. Miller	800		do	New Comerstown, Ohio.
		S. J. Crites	2,456		do	Dover, Ohio.
		Geo. Ault	2,108		do	Do.
		Wm. Weal	500		do	New Philadelphia, Ohio.
		Wm. Noftsker	400		do	Points on Ohio canal.
		Geo. Mathias	2,500		do	New Philadelphia, Ohio.

Directory of bituminous coal mines—Continued.

OHIO—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	TUSCARAWAS COUNTY—continued.			*Feet.*		
	Fairfield township	John L. Kennedy	100		Bituminous	New Cumberland and country.
	do	David Burgess	140		do	Canal Dover and country.
	do	B. H. Riggle	40		do	Country.
	do	Mrs. W. H. Powell	140		do	New Cumberland and country.
	do	Thos. Scott	120		do	Do.
	do	David Shively	80		do	Do.
	Washington township	John Fivecoats	750	4	do	Surrounding country.
	Franklin township	Philip Zigler	1,500	5	Bituminous, open-burning	Strasburgh and Winfield.
	do	Jos. Patterson	1,000	5	do	Beach City and Strasburgh.
	do	Hull & Warner	500	4	do	Strasburgh and vicinity.
	VINTON COUNTY.					
Hope Furnace mine, No. 6 seam.	Hope furnace	H. Heasly	2,400	3	Bituminous, open-burning, purple ash.	Along Marrietta and Cincinnati R. R.
Moonville mine, No. 6 seam	Moonville	do	1,200	3	do	Do.
Town mine, No. 4 seam	Zaleski	Zaleski Co	35,000	3¾	Bituminous, open-burning, white ash.	Do.
Coalmont mine, No. 6 seam	do	do	18,000	4½	do	Do.
	Wilkesville	John Blore	600		Bituminous	Wilkesville and Salem, Ohio.
	WASHINGTON COUNTY.					
		D. Rumble	1,200		Bituminous	Lowell and vicinity.
		Mrs. Starling	200		do	Do.
		Mr. Norman	200		do	Do.
		W. K. Ellison and others.	1,200		do	Do.
		Nick Basil	400		do	Do.
		Coal Run, or Sycamore M. Co.	21,600		do	Steamboats on Muskingum river.
		Parties in Waterford township.	800		do	Waterford township.
		Parties in Wesley township.	960		do	Wesley township.
		Parties in Newport township.	640		do	Newport township.
		Parties in Maxburg and Vic.	1,600		do	Maxburgh and vicinity.
	Waterford township	Gordin, Hardin & Co	2,649		do	Marrietta and Beverly, Ohio.
	WAYNE COUNTY.					
Mobile mine	Doylestown	H. C. Galehouse	2,500	4	Bituminous, open-burning, white ash.	Smithville, Doylestown, Easton, Ohio, and neighborhood.
Silver Creek mine	do	Silver C. M and R. R. Co.	42,378	4	do	Toledo and Cleveland, Ohio, Detroit, Mich., and Collinwood, Ohio.
		Edgell Bros	800		Bituminous	Neighborhood.
		Seibling, Miller & Co	1,500		do	Do.
		Edwin Baysinger	1,000		do	Do.
		M. Elhenny & Stenson.	2,000		do	Wooster, Ohio.
		Roebuck & Co	1,100		do	Do.
		Elias Mast	800		do	Neighborhood.
		Charles Stait	300		do	Do.
		M. Clarke	400		do	Do.
		Asaph Rumbaugh	300		do	Do.
		Barney Flowers	350		do	Do.
		Christopher Beckar	400		do	Do.
		Mrs. Flory	400		do	Do.
		J. L. Smith	350		do	Do.
		Peter Frazer	300		do	Do.
		Thos. Davis	450		do	Do.
		Benj. Davis	400		do	Do.
	Salt Creek township	Bernard Farine	225		do	Home.

OREGON.

	COOS COUNTY.					
Eastport Coal Co.'s mine	⅞ mile southwest of Eastport.	Merchants' Exchange.	16,800	6½	Lignite	San Francisco.
Newport Coal Co.'s mine	3 miles southwest of Marshfield.		26,405		do	San Francisco and Coos bay.
South Port Coal Co.'s mine	7 miles from Marshfield.		None.		Lignite, quite hard	

Directory of bituminous coal mines—Continued.

PENNSYLVANIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ALLEGHENY COUNTY.			*Feet.*		
Eagle Nest mine, Pittsburgh seam.	Coultersville	Wm. Duncan	6,840	5	Bituminous, gas	Pittsburgh and Cin., via Youghiogheny, Monongahela, and Ohio rivers.
Enterprise mine, Pittsburgh seam.	Banksville	Hartley & Marshall	106,854	4½	Bituminous, gas, steam	New Orleans, Chicago, Buffalo, Cleveland, and all lake intermediate points, via Ohio and Pittsburgh and L. Erie R. R. and connections.
——, 6-foot seam	Elizabeth	Horner & Roberts	85,511	4½	Bituminous	
Pine Run mine	Coal Valley	James Lynn & Co	69,118	4½	do	Cincinnati, Louisville, and New Orleans, via Ohio and Miss. rivers.
Ormsly, Bausman & Knox's mine, Pittsburgh seam.	Pittsburgh	Birmingham C. Co	218,060	4½	do	Pittsburgh to New Orleans, via Ohio and Miss. rivers.
Six-mile Ferry Nos. 1 and 2 mines, Pittsburgh seam.	Baldwin and Mifflin township.	H. B. Hayes & Bro	69,563	4½	do	River ports from Pittsburgh to New Orleans, via Monongahela, Ohio, and Miss. rivers.
McConnell's mine	Walker's mills	Jos. McConnel	15,750	4½	do	Pittsburgh.
Belview mine	Hites	Belview Coal Co	23,040	6	do	
Beck's Run mine, Pittsburgh seam.	Lower Saint Clair township.	H. B. Hayes & Bro	33,130	4½	Bituminous, gas	Pittsburgh to New Orleans, via Monongahela, Ohio and Miss. rivers.
Robbins, Lynn & Co.'s mine, Pittsburgh seam.	Milesville	Robbins, Lynn & Co	22,800	5	Bituminous	Cincinnati, Louisville, and New Orleans, via Monon., Ohio, and Miss. rivers.
Bellevue mine	Bellevue	Gumbert & Huey	49,368	5½	Bituminous, almost free from sulphur and other impurities.	Cincinnati, Ohio, Louisville, Ky., via Monongahela and Ohio rivers.
Clark mine, Pittsburgh seam.	Bridgeville	Jas. Clark	23,730	4½	Bituminous	Pittsburgh and N. W. markets, via Pbg., Cin. and St. Louis R. R., P. T. W. R. R., and C. R. W. R. R.
Venture mine, Pittsburgh seam.	Banksville	Grey & Bell	55,480	4½	do	Pittsburgh and lower river cities, via Saw Mill Run R. R.
Coal Ridge mine, Pittsburgh seam.	do	do	50,540	4½	do	Pittsburgh, via Saw Mill Run R. R.
Chess mine, Pittsburgh seam.	35th ward, Pittsburgh	do	35,000	4½	do	Pittsburgh rolling-mills.
Robbins & Jenkins mine	Monongahela river	Robbins & Jenkins	57,905		do	River markets, via Ohio and Monongahela rivers.
Lovedale mine	Elizabeth	Wood, Schrader & Co	62,687		do	River markets, Ohio, etc., via Ohio river.
Enterprise mine, Pittsburgh seam.	West Elizabeth	O'Neil & Co	82,899	4	do	Cin., Louisville, Memphis, Arkansas City, Natchez, and New Orleans, via river.
Old Eagle mine	Elkhorn	W. H. Brown	27,007	4½	Bituminous; steam and gas	Cin., Cairo, St. Louis, New Orleans, via Monongahela, Ohio, and Miss. rivers.
Wm. Stone mine	McKeesport	Wm. Stone's heirs	95,000	4½	Bituminous	Cin., Ohio, via Ohio and Monongahela rivers.
Oak Hill No. 4 mine	Turtle Creek	N. Y. and Cleveland Gas C. Co.	323,152	4½	Bituminous; gas	Pittsburgh, Cleveland, Chi., Milwaukee, and Canada, via Pa. R. R. and C. and P. R. R.
Oak Hill No. 3 mine, Pittsburgh seam.	do	do	36,241	4½	do	Do.
Plum Creek mine	Plum Creek	do	254,930	4½	Bituminous	Pittsburgh, via Allegheny Valley R. R.
Sandy Creek No. 1 mine, Pittsburgh seam.	Sandy Creek	do	260,962	4½	Bituminous; gas	Do.
Duquesne mine, Pittsburgh seam.	Edgewood station	do	20,302	4½	do	Pittsburgh, via Penn. R. R.
Corey & Co	Braddocksfield	Corey & Co	25,308	5	do	East and west on Penn. R. R., B. and O. R. R. Co., P. R. R., Pbg. and C. and St. L., A. V. R. R., C. and P. R. R., B. and O. R. R., P. S. L. E. R. R., and all roads at Pittsburgh.
Montour & Cliff mine	Imperial	Imperial Coal Co	88,361	4½	Bituminous	Lake Erie ports, via Pbg. and L. Erie R. R., and N. Y. P. and O. R. R.
Fort Pitt mine, Pittsburgh seam.	Fort Pitt station	Fort Pitt Coal Co	30,000	4½	Bituminous; steam and gas	Local Pittsburgh trade and western cities, via P. C. and S. L. R. R.
Cherry mine	Hay's Crossing	Morris McCue	31,249	4½	Bituminous	Pittsburgh and east and west.
Nixon mine	Leetsdale	Chartiers Valley C. Co.	25,080	4½	do	Pittsburgh and Allegheny City, via P., C. and St. L. R. R.
Summer Hill mine	Woodville	Frank Armstrong	28,672	3½	do	Pittsburgh, via P., C. and St. L. R. R.
Fairhaven mine	Fairhaven	Pittsburgh and Castle Shannon R. R. Co.	103,209	4½	Bituminous; rolling-mills and glass-houses.	Pittsburgh, via own road.
American Iron Works' mine, Pittsburgh seam.	Pittsburgh	Jones & Laughlin	81,250	4½	Bituminous	Works of Jones & Laughlin.
Green Spring mine	Braddock	Thomas Faucett	91,200	4½	do	Cin., Louisville, and New Orleans, via Ohio, Monongahela and Miss. rivers.
Keystone mine, Pittsburgh seam.	Saltsburg	W. H. Brown's heirs	181,213	4½	do	Cin., Louisville, Cairo, Memphis, New Orleans, and St. Louis, via Mon., Ohio, Miss., and Upper Miss. rivers.
Cornell & Werlings' mine, Pittsburgh seam.	Allegheny	do	103,300	4½	do	Cin., Louisville, and points on Miss. river, via Ohio and Miss. rivers.
Braddock Gas-Coal mine	Wilkins township	John Giles	1,900	4½	do	Pittsburgh and Allegheny City.
	Leasdale	Lindsay M. Causland	5,000	2	do	Neighborhood.
Phœnix Gas-Coal Company's mine.	Chartiers and Union townships.	F. C. Negley, T. C. Dickson, and J. B. Stewart.	6,960	6	Bituminous; steam, iron, and gas manufacturing.	Pittsburgh, Chi. and lake trade.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ALLEGHENY CO.—cont'd.			*Feet.*		
Squirrel Hill mine	Twenty-second ward, Pittsburgh.	Alfred Harrison	9,120	4	Bituminous, lump and slack.	East Liberty and Oakland.
Glenshaw mine, Freeport seam.	Glenshaw	Thomas W. Shaw	3,192	3½	Bituminous	Home.
Pleasantville mine	Harrison township	Jackson Pugh	1,140	3	Bituminous, hard block	Natrona and Tarentum.
Sable Coal Works mine	Pennsylvania twp	M. Durkin	9,944	5	Bituminous	Pittsburgh.
McCauley Brothers' mine	Wilkins township	James McCauley	1,900	4½	do	Braddocks and suburbs.
Etter mine	Wilkinsburgh	John Etter	7,200	4½	do	Pittsburgh and suburbs.
Etna and Vesuvius mine, Freeport seam.	Hites	Belview Coal Co	33,989	5	do	Pittsburgh and Allegheny City, via W. Penn. R. R.
Eclipse mine	Saw Mill run	John Carlin & Co	17,733	4½	do	Pittsburgh, Cleveland, Buffalo, Youngstown, and Meadville, N. Y., and B. and O. R. R. Co., via Little Saw Mill R. R., P. and G. E. Q. S. and M. S. and N. Y. P. and O. R. R.
Camp Hill mine, Pittsburgh seam.	Scott and Collier townships.	Steen & Sons	68,400	4½	Bituminous, very hard	Pittsburgh, via P. C. and S. L. R. R.
Bower Hill mine	Bower Hill	A. J. Schulte	37,333		Bituminous	Pittsburgh, and all points east and west, via P. C. and S. L. R. R. and P. F. W. and E. R. R. and connections.
M. Graver & Co	Pennsylvania twp	M. Graver & Co	35,729	4½	Bituminous; gas	Pittsburgh and oil regions, via A. V. R. R.
Mansfield C. and Coke Co., Mansfield seam.	Mansfield	Mansfield C. and Coke Company.	100,872	4½	Bituminous, block; gas	Erie, Cleveland, Ashtabula, Toledo, Chi., and western country, and Dominion of Canada.
J. Weinman mine	Wilkinsburgh	J. Weinman & Co	7,904	5	Bituminous	East Pittsburgh and Wilkinsburgh.
Oak Hill mine, Pittsburgh seam.	Allegheny	Dickson, Stewart & Co	23,187	4⅜	Bituminous; gas	Pittsburgh and western and northern points, by lake and R. R.
Grant mine	Mansfield	Grant Coal Company	45,332	4½	Bituminous; steam and gas	Erie, Pittsburgh, New Castle, Sharon, and Sharpsville, via P. C. and St. L. R. R., and P. F. W. and C. and E. and R. R. R.
Willow Grove mine	Willow Grove	T. B. Robbins & Co	28,445	3–4½	Bituminous, block; steam and gas.	Principal points in northwest Indiana, Ohio, and Ill., via P. C. and St. L. R. R., and J. B. and W. T. P. and W.
National mine, Pittsburgh seam.	Allegheny	National C. Co., lim	21,325	4	Bituminous; steam, gas, and forge.	Pittsburgh and Allegheny, Ohio, Ind., Ill., and Iowa, via P. C. and St. L. R. R., J. B. and W. R. R., T. P. and W., and N. C. R. W.
Oak Ridge mine, Pittsburgh seam.	Oakdale	Oak Ridge C. Co., lim	37,317	4½	Bituminous	Pittsburgh, via P. C. and St. L. R. R.
Alpsville mine	Alpsville	Carroll & Dunn	26,057	4⅜	do	McKeesport and Pittsburgh, via B. and O. R. R.
Youghiogheny mine, Pittsburgh seam.	Elizabeth township	James O'Neil	46,537	5	do	Cin., Louisville, Memphis, New Orleans, and St. Louis, via Ohio, Miss. and Mon. rivers.
Penney mine	Lincoln township	Penny Coal Company	52,440	4½	do	Cin. and Louisville, via Ohio river.
Jones' mine	W. Elizabeth	Mrs. George Jones	43,677	5	do	Pittsburgh, Mon. slack-water.
Hampton mine, Pittsburgh seam.	Wilkinsburgh	John McIntyn	73,530	4⅜	do	Pittsburgh and western points on lakes and R. R.
Jefferson mine, Pittsburgh seam.	Coal valley	Foster, Clark & Wood	56,083	4½	do	New Orleans, via Monongahela, Ohio, and Miss. rivers.
Camden mine	Camden	George Lyde & Sons	62,700	4	do	Cin., Louisville, and New Orleans, via Ohio and Miss rivers.
Wenona mine	Wenona	Jas. Skillen	8,360	4½	do	Pittsburgh, via Mon. river.
Habesman mine	Baldwin	Jos. Walton & Co	67,526	4½	do	Cin., Louisville, and New Orleans, via Mon., Ohio, and Miss. rivers.
Lower Works mine	West Elizabeth	do	90,755	4½	do	Do.
Upper Works mine	Petersburgh	do	81,298	4½	do	Do.
Aunty mine	Dravosburgh	J. C. Risher	75,620	4 5/12	Bituminous; gas and manufacturing.	Do.
Wood mine	Chartier's township	Wettengel & Garmley	27,620	4⅜	Bituminous, lump and slack	Allegheny City and Pittsburgh.
Windbridle mine	East Liberty	Jacob Weinman	4,370	5	Bituminous	East Pittsburgh.
Penna. Salt Manufacturing Co's mine, first seam.	Natrona	Penna. Salt Manufacting Co.	34,232	2⅜	do	Natrona works and employés.
Nimick mine	Union township	Thos. Fox	11,825	4½	do	Allegheny and Pittsburgh.
Rock Run mine	Rock Run	W. J. Snodgian	24,000	4	do	Cin., Louisville, and New Orleans, via Mon., Ohio, and Miss. rivers.
Wm. Neal's mine, River seam.	McKeesport	Wm. Neal (deceased)	29,216	4	do	Western points along Ohio and Miss. rivers.
Allequippa mine, Pittsburgh seam.	Camden	Wigham, Baily & Co	51,147	4	do	Cin. and New Orleans, via Mon., Ohio, and Miss. rivers.
Glendale mine	Scott township	S. B. Gregg	13,680	4½	do	Chi., via P. C. and St. L., and S P. and W. and C. R. R.
Sreet's Run mine, 4-foot seam.	Hope Church	I. D. Risher	68,439	4	Bituminous; gas	Louisville and N. Orleans, via Ohio and Miss. rivers.
Osceola Coal Co.'s mine, Pittsburgh seam.	Osceola	Osceola Coal Co	68,360	4½	Bituminous	Balt., Pittsburgh, Braddock, Demmler, and McKeesport, via B. and O. R. R. and Yough. river.
	Natrona	W. A. Nisbet	2,000	4	do	Home and neighborhood.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ALLEGHENY CO.—cont'd.			*Feet.*		
.....	Logan's Ferry	Jos. Farneth	1,140	4½	Bituminous	Neighborhood.
.....	.....	Caleb Foster	950	5	do	Do.
.....	Versailles township	W. R. Cooper	1,020	3⅔	do	McKeesport and neighborhood.
.....	Buena Vista	S. & K. Eichar	907	6	do	Buena Vista and country.
.....	Moon township	Wm. Onstott	589	5	do	Neighborhood.
.....	Shaler township	J. H. Hieber	1,422	2–4	do	Do.
.....	Mansfield	John Rosser	541	4½	do	Do.
.....	West End	Wilmore W. Morris	1,140	4¼	do	Neighborhood and home.
.....	West Deer township	A. Martin	789	3½	do	Neighborhood.
.....	Wilkinsburg	John H. Ward	1,140	5	do	Do.
.....	Baldwin township	Lewis Matthews	608	4½	do	Neighborhood and home.
.....	Rich Hills	Wm. Mason	675	4½	do	Neighborhood.
.....	Banksville	David Harris & Bro	1,216	4	do	Pittsburgh and neighborhood.
.....	Steubenville pike	Jacob Jackson	2,500	4½	do	Home and neighborhood.
.....	21st ward, Pittsburgh	Isaac O. McMinn	1,140	4½	do	Neighborhood.
.....	West Liberty	John Smith	1,520	4	do	Do.
.....	do	Chas. Lees and Wm. Woodall.	1,026	4½	do	Do.
.....	Baldwin township	M. Englert	760	.....	do	Do.
.....	Maple Valley	Benj. Hallam	2,090	4¼	do	Do.
.....	Bridgerville	Sam'l Rimmell	627	4½	do	Do.
.....	Rich Hill	Jas. Marshall	1,536	5	do	Do.
.....	Knoxville	Knoxville Land Impt. Co.	950	4¼	do	Home and neighborhood.
.....	Elizabeth	David Cochenour	786	5	do	Neighborhood.
.....	Penn township	J. Blackadore	2,774	4½	do	Home and neighborhood.
.....	Near Allegheny	Jas. L. Orr & Co	2,660	4	do	Neighborhood.
	ARMSTRONG COUNTY.					
Rimerton mine, Middle Freeport seam.	Rimerton	Rimerton C. and Min. Co.	4,451	3½	Bituminous, soft	Oil City to Buffalo.
Mahoning Fce. mine, Middle Freeport seam.	Mahoning Furnace	Wesley Wilson & Co	2,200	4	Bituminous; coke, steam, domestic, blacksmithing, and furnace.	
.....	E. Franklin township	P. Mechling	2,140	3½	Bituminous	Kittanning.
Leechburgh I. Works mine	Leechburgh	Kirkpatrick & Co	9,000	4	do	Own works.
.....	do	Jos. E. Beale	7,800	4	do	Own use, and neighborhood.
New Bethlehem mine	New Bethlehem	Sandy Lick Gas, Coal and Coke Co.	10,134	.....	do	
Stewartson Furnace mine	Mahoning	F. B. & A. Laughlin	15,100	.....	Bituminous, furnace	Furnace.
.....	S. Buffalo township	Jas. Stewart	1,800	.....	Bituminous	R. R. pump station.
Red Bank mine	Mahoning	Red Bank Mining Co	9,600	.....	Bituminous, soft cannel	N. Y. Central.
.....	Cowanshannoc twp	Wm. Roof	562	.....	Bituminous	Surrounding country.
.....	Kittanning	Moses Murphy	1,200	4 10/12	do	Neighborhood.
.....	Worthington	Graff & Firth	800	4	do	Neighborhood, and own use.
.....	Kiskiminitas	John Gamble & Son	1,900	3½	do	Own use.
.....	Kittanning	Ross Reynolds	1,408	4	do	Do.
.....	Brocketville	Emanuel Hellier and Jos. Stenitte.	664	3 10/12	do	Neighborhood.
.....	Kittanning	Henry C. Keller	960	3¾	do	Do.
.....	do	A. Thompson	800	3	do	Do.
.....	Templeton	Peter J. Brice	800	2	Bituminous, soft	Neighborhood and own use.
.....	Freeport	John Kennedy	1,000	.....	Bituminous	Neighborhood.
.....	Leechburgh	L. A. Keppel	800	4	do	Do.
.....	North Freedom	Enoch Booser	780	4½	do	Do.
.....	Queenstown	Edw. Jennings	960	4	do	Do.
	BEAVER COUNTY.					
.....	Brush creek	Charles Cunning	800	4	Bituminous	Neighborhood.
Ebness mine, 3-foot seam	Pulaski township	James M. Nugent	1,200	2½	do	Beaver Falls and vicinity.
Point Breeze mine, Block seam.	Glasgow	W. H. Wallover	95	2⅙	Bituminous, soft block	Glasgow.
Wolf Run mine, Stone seam	Brighton township	A. M. Harn	570	2	Bituminous	Bridgewater.
Enon mine	Darlington township	William Pickles	1,520	3	Bituminous; blacksmithing.	Enon valley and country trade.
Elizabeth mine	Georgetown	Orr & McKinley	400	4	Bituminous; steam and domestic.	East Liverpool, Ohio.
Bolsville mine	Rochester township	Patrick McLaughlin	2,756	2 7/12	Bituminous	Rochester and Bolesville.
Couch mine	Pulaski township	O. H. Couch	4,800	2	do	New Brighton Pottery Company.
Dawson mine	Ohioville	Daniel Dawson	2,318	4	do	Oil wells and country trade.
Beaver Block mine	Cannelton	James Suthern	8,290	2–3½	do	Cleveland and Youngstown, via P. F. W. and C. Y. P. and E. P. R. R

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BEAVER CO.—cont'd.			*Feet.*		
Mansfield Cannel mine, No. 4 seam.	Cannelton	J. F. Mansfield	23,100	8	Cannel	N. Y., Boston, Buffalo, Erie, Cleveland, Chi., via P. and H. W. and C. and R. R. R. and vessels and Erie canal.
Baker mine	Clinton	L. S. Hoyt	33,000	8	Bituminous	Penna. R. R. Co., via E. and P. R. R.
Davidson mine	Beaver Falls	A. Davidson	3,351	2	do	Beaver Falls.
Beaver Falls mine	Beaver	George Bolan	1,432	2½	do	Do.
Forksburgh mine	New Brighton	Henry Fish	1,520	2	do	New Brighton and vicinity.
Glass mine	do	G. W. Glass & Bros	19,000	2	Bituminous, very hard	New Brighton and own use.
Clayton mine, Upper and Lower Freeport seams.	Beaver Falls	J. and W. F. Clayton	4,464	3 5/12	Bituminous	Beaver Falls.
	Industry	John Duck	1,710		do	Own use.
	Near Cannelton	F. Butts	900		do	Cleveland, Ohio.
	Pulaski township	John Brain	863		do	
Barens mine		Walter Young	1,131		do	Neighborhood.
	Pulaski township	Job Cook	684		do	Do.
Ross mine		James H. Coburn	529		do	Do.
	Glasgow	Henry Udick	577		Bituminous, soft	Do.
	Smith's Ferry	W. C. Timmins	615		Bituminous, block	Own use.
	Near New Brighton	Henry Barr	402		Bituminous	Do.
	New Brighton	O. Molton	512		do	Neighborhood.
	Rochester township	William Moon	475		do	Neighborhood and New Brighton.
	Industry	Gomer E. and David R. Lewis.	600		do	Neighborhood.
	New Galilee	J. S. Hudson	760		do	Do.
	Raccoon Creek	J. C. Frank	576		do	Own use.
	Rochester township	John J. Foster	570		do	Neighborhood.
	Coal Pit run	William Bromley	509		Bituminous and cannel	Do.
	Hookstown	John B. Swany	380	4	Bituminous	Do.
	Darlington	John N. Craft	855	2½	do	Neighborhood and home.
	Smith's Ferry	Daniel Wolf	380	1⅔	do	Neighborhood.
	Rochester	Jos. Anderton	893		do	Do.
	Pulaski township	Thomas and Jas. Funkhouser.	2,660	2½	Bituminous, hard	Do.
	Brown's	Jerome Powell	760	2	Bituminous	Do.
	do	Hannah Robinson	760	2	do	Do.
	BEDFORD COUNTY.					
Mt. Equity and Parrott mine, Kelley seam.	Six Mile Run	Kemble Coal and Iron Co.	45,682	3	Semi-bituminous	Riddlesburgh.
Lane and Cambria mine, Kelley seam.	Sandy Run	Richard Langdon	38,500	4½	Bituminous; coke and steam	Philadelphia and Baltimore.
Duval mine, Cook seam	Fairplay	Meors Bros	7,984	3⅔	Semi-bituminous	New York and Brooklyn.
	BLAIR COUNTY.					
Porter mine, Miller seam	Allegheny township	Denniston, Porter & Co.	63,338	2 11/12	Semi-bituminous	Rolling-mills, factories, lime kilns in Blair Co., also blast-furnaces.
Tunnel Hill mine, 4-foot seam	Bennington	Kittanning C. Co	6,510	4	do	Philadelphia.
Glen White mine, Miller seam.	Glen White	Glen White C. and Lum. Co.	21,109	2½	Semi-bituminous, coke	
Coal Bank mine	Near Hollidaysburg	H. R. Myers	2,117	3	Semi-bituminous	Hollidaysburgh, Altoona, and neighborhood.
Horseshoe mine	Logan township	S. C. Baker	19,800	4	do	Neighboring furnaces and rolling-mills.
Bennington mine, Miller seam.	Bennington	Blair I. and C. Co	118,209	3	do	Hollidaysburgh, via Pa. R. R.
	Logan township	E. G. Kelly	4,750		Bituminous	
	Near Bennington	Denniston, Porter & Co.	58,000	3	Semi-bituminous	Iron works in Blair and adj. counties.
	BRADFORD COUNTY.					
Carbon Run mine, B seam	Carbon Run	Schraeder Coal Co	215,202	4	do	Northern part of state of N. Y.
Towanda Coal Co.'s mine, B seam.	Barclay	Towanda Coal Co	285,763	3½	do	N. Y., Lake Erie and Western R. R. Co.
	BUTLER COUNTY.					
Acbarr mine	Hilliard's	Acbarr Min. Co	682	5 7/12	Bituminous, peacock	Erie, Buffalo, and Meadville, via E. and P. R. R., L. and A. R. R., E. and P. R. R., the lakes, and N. Y., P. and O. R. R.
Fullerton mine	Karns City	Wm. Penberthy	2,577	3	Bituminous	P. and K. C. R. R. and Parker Glass Co. line, via P. and K. C. R. R. and K. C. and B. R. R.
Barnes mine, Kittanning seam.	Harrisburgh station	Mercer Min. and Mfg. Co.	99,167	3	do	Cleveland, Erie, and Meadville, via Shenango and Allegheny, E. and P., and N. Y., P. and O. R. R.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BUTLER CO.—cont'd.			*Feet.*		
Burnett mine	Hilliard's	Burnett C. and Coke Co.	17,500	11⅝	Semi-bituminous, coke	Erie, Meadville, and Buffalo, via E. and P. R. R., N. Y., P. and O. R. R., Erie, and lakes.
Gallespie & McEntier mine	Freeport township	J. O. Mealy	1,520	3⅔	Bituminous	Freeport Town, Quekenherness & Bro.'s distilleries.
Harrisville mine	Harrisville	W. P. Brown	340	3½	do	Harrisville.
Kirk mine	Butler township	Elias W. Kirk	1,200	4	Bituminous, soft	Country trade.
McQuiston mine	Butler	Robert Clark	530	3⅝	Bituminous	Butler.
Watson mine, Summit seam	Fairview	Andrew Watson	1,057	2⅝	Bituminous, block	Neighborhood.
Schaffner mine	Near Butler	Samuel Schaffner	760	3¼–4	Bituminous, gas	Butler.
Bredin mine	Butler township	Jacob Schwillie	1,624	3⅝	Bituminous	Do.
	Donegal township	C. Weiner	1,630	3½	do	Millerstown.
Studebaker mine	Worth township	Jos. H. Studebaker	670	3¼	do	Butler, Mercer, and Lawrence counties.
Henry mine, 3-foot seam	Butler	Noah Henry	1,140	2⅞	Bituminous; smithing	Butler and small country trade.
Walas mine, 3-foot seam	Karns City	Tack, Moorhead & A. B. Evans.	2,280	3⅔	Bituminous	United Pipe Line pump station, and wells in neighborhood.
Negley Seam mine, Negley seam.	Butler	John N. Muntz	1,150	3½	do	Butler.
Coal Valley mine	Allegheny township	B. F. Hitchcock	1,100	2⅔	do	Local trade.
Union C. and Coke Co.'s mine, Middle Kittanning seam.	Coalville	Boyce, Spearman, Rawle, Kinsbury & Staye.	None.	3	Semi-bituminous, block	Greenville, Cleveland, and Erie.
	North Hope	William Jenkins	600		Bituminous, cannel, block	Oil wells and vicinity.
	Winfield township	James Simmers, jr	350	3	Bituminous	Neighborhood and home.
	Parker	N. H. Beatty	646	5⅔	do	Do.
	Parker Landing	Potts Bros	1,144	3	do	Neighborhood.
	Jackson township	Samuel Shoffen	836	3	do	Neighborhood and home.
	Harmony	Zatty, Mohr & Rader	912	3	do	Do.
	Rodger's Farm	R. J. Lewis	684	3⅔	Bituminous, soft	Neighborhood.
	Petrolia	John Kagan	456	2	Bituminous	Do.
	do	Thomas L. Thomas	874	4	do	Neighborhood and home.
	Unionville	Eli D. Eagal	800	3¾	do	Neighborhood.
	Sandy Point	J. W. Zimmerman	608	3 1/11	do	Do.
	Martinsburgh	William Storey	720	6	do	Do.
	do	D. L. McKelvey	760	5	Bituminous, soft	Do.
	do	A. Jenkins	418	2½	do	Do.
	Saint Joe	Samuel Thornberg	570		Bituminous	Do.
	Butler	John McElroy	646	3½	do	Neighborhood and home.
	Portersville	William Covert	1,520	4	do	Neighborhood.
	Saint Joe	Matt. Caslow	720		do	Do.
	Butler	McGailey & Medoker	695	3	do	
	Parker township	T. M. Barnes	1,057	3½	do	Neighborhood and home.
	Millford Farm	Karne, Wangler, McCleod & Stewart.	1,261	4	do	Do.
	Sloan Farm	J. M. Sloan	622	3½	do	Neighborhood.
	Centre township	Henry Scibohl	760	2⅝	do	Neighborhood and home.
	Millerstown	David T. Hodges	565	2¾	Bituminous, soft	Neighborhood.
	Barker	T. M. Barrun	95	3½	Bituminous	Oil mills.
	do	Watson & Son	[illegible]	2½	do	Home.
	do	J. Kusick	43	5	do	House and oil mill.
	do	Patt & Bro	1,320	3	do	Parker City.
	do	D. S. McKay	200	4	do	Oil mills.
	do	P. Sweny	70	4	do	Do.
	Donegal township	Frederick Damm	562	3½	Bituminous, soft	Neighborhood.
	Mercer township	Saml. Walters	877	3¾	Bituminous	Neighborhood and home.
	CAMBRIA COUNTY.					
Bens Creek mine, B seam	Washington township	S. H. Smith	28,993	4	Semi-bituminous	Altoona, Phila. and points west of Pittsburgh.
——, Lemon seam	Taylor township	D. Prosset	2,822	2¾	do	Home.
Lloyd mine, B seam	Lloydsville	Bells Gap R. R. Co	91,837	5	Semi-bituminous, very tender, free from much pyrite.	Home, via Pa. R. R.
Cement Mill mine, Cement and Limestone seam.	Johnstown	A. J. Haw	14,784	3½	Bituminous	Home.
Sonman mine, B seam	Sonman	W. H. Piper & Co	104,400	4½	do	Balt., Phil., N. Y., N. E. states, main line of P. R. R. in Pa.
Stineman mine, B seam	South Fork	J. C. Stineman	18,000	4¼	Bituminous, very tender	Phila.
Plack & Fogle mine, Lemon seam.	Hemlock	Caron & Leahry	4,200	4½	Bituminous; coke, iron manufacturing, lime kiln, and brick burning.	Cambria, Blair and Huntingdon co's, also Cleveland, Ohio, and N. J.
S. Fork C. Works mine, B seam.	South Fork	S. Fork C. Works Co	18,000	4	Bituminous	Altoona and Eastward.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CAMBRIA CO.—cont'd.			*Feet.*		
Hopkins & Griffith mine, Cement seam.	Conemaugh Boro	Hopkins & Griffith	5,600	3⅝	Bituminous; domestic and steam.	Johnstown and domestic.
Cueshon mine	do	Cambria Iron Co	8,460		Bituminous	
Rolling Mill mine	Lower Yoder township	do	185,920		do	
Gautier mine	Conemaugh Boro	do	18,225		do	
Lilley Sta. C. and Coke Wks. mine.	Lilley Station	Jas. H. Dysart & Co	6,000		do	
Conemaugh mine	E. Conemaugh	Cambria Iron Co	26,000		do	
Martin mine, E and B seam	Martindale	John C. Martin	10,000	9	Semi-bituminous	Pa., N. Y., and N. E. states.
Woodvale mine, Miller seam		Johnstown Mfg. Co	18,013		do	Home.
Mentzer's Bens Creek mine	Bens Creek	E. W. Mentzer	18,701	4	Bituminous	
	Stony Creek and Conemaugh.	Ebenezer James	2,000	3½	do	Johnstown, Pa.
	do	John Horrocks	1,200	3⅝	do	Do.
	do	Thomas Gore	550	3¼	do	Do.
	do	Jacob Levergood	700	3	do	Do.
	do	John Bishop	550	4	do	Do.
	Dayton township	Benjamin Benchoff	1,500	4	do	Home.
	do	Cambria Iron Co	1,200	4	do	Do.
	Gallitzin township	G. A. Christy	2,000	5	do	Lorette and Gallitzin.
	do	Daniel Hanlon	420		do	Chessprings and Gallitzin.
	CAMERON COUNTY.					
Mount Hope mine, Mount Hope seam.	Cameron	Jacob Elias	43,000	3	Bituminous	Buffalo from Chutes to Emporium, thence to Buffalo, via B. and N. Y. R. R.
	CENTRE COUNTY.					
Snow Shoe mine, B, D, and F seams.	Snow Shoe	Bellefonte and Snow Shoe R. R. Co.	85,731	14¼	Bituminous; iron working, making gas and coke.	Bellefonte, Williamsport, Milton, Northumberland, Catasaugua, Pottstown, via Bellefonte and Snow Shoe R. R., Bald Eagle Valley R. R., and Pa. R. R. and connections.
Black Diamond mine	Powelton	William J. Jackson	45,840	4	Bituminous; steam	Greenwich and Cuba.
Coal Bank mine	Bush township	Enterprise C. Co	None.		Bituminous	
	CLARION COUNTY.					
Mineral Ridge C. Co.'s mine, Kittanning seam.	Monterey	T. J. Skidmore	52,393	3¼	Bituminous; steam	Buffalo, N. Y., Irvineton, via A. D. R. R., P. T. and B. R. R., D. A. V. and R. R. R., and L. S. and M. S. R. R.
J. B. Miller mine	Sligo	J. B. Miller	2,270	3	Bituminous	Owner's works.
Kribbs mine	Beaver city	Edwin Rawe	500	2	do	Oil wells.
Church Hill C. Co.'s mine, Kittanning seam.	W. Monterey	Church Hill C. Co	6,000	3	do	Oil City, Buffalo, via Allegheny Valley R. R. and B. and S. W. R. R.
Clarion C. Co.'s mine, Clarion seam.	Clarion	Clarion Coal Co	20,200	3⅝	do	Along line Foxburgh Clarion R. R., Clarion town, via Foxburgh and St. Petersburgh R. R., Emlenton and Shippensville and Clarion R. R.
Pittsburgh C. and M. Co., Catfish seam.	Catfish	Pittsburgh C. and M. Co.	55,000	3½	Bituminous, hard, very strong	Buffalo, all western Ontario, via A. V. R. R., P. F. and P. R. R., B. and S. W. R. R., N. Y. and H. R. R. R., N. Y. L. E. and W. R. R., Gt. West. R. R., and Grand Trunk R. R.
Fairmount mine, Lower C and Lower Freeport seams.	Fairmount City	Fairmount Coal Co	77,424	11	Bituminous	Titusville, Pa., Buffalo, N. Y., and Can.
Pine Run C. and M. Co., C seam.	East Brady	Stephenson & Mitchell	12,225	3⅝	do	Buffalo, Erie, Oil City, Franklin, and Foxburgh, via A. V. R. R., P. T. and B. R. R., B. and S. W. R. R., and L. S. and M. S. R. R.
Brady's Bend mine	do	Brady's Bend Min. Co.	18,000		do	Line of A. V. R. R.
Black Diamond mine	Knox	Daniel Barnett	1,070	3	do	Elk City and Beaver township.
Benninger mine	Madison township	James Benninger	400		do	Surrounding country.
	Beaver township	D. Foster	600		do	Elk City and vicinity.
	Ashland township	Joseph Sneddai	6,000		do	Edinburgh, Pa.
Sligo Branch C. Co	Madison township	Sligo Branch C. Co	21,279		do	Oil City and Buffalo, N. Y.
Red Bank Fce	On A. V. R, R	Reynolds & Co	None.		do	Furnace.
	Brinkerton	Samuel Reed	600	3	do	Neighborhood.
	Perryville	John Youngling	556	3	do	Do.
	Clarion	S. G. Sloan	456	3	do	Neighborhood and home.
	Brady township	William Jardine	1,160	4	do	Do.
	Vic. of Stone House	Buzza & Snedden	833	2 5/12	do	Neighborhood.
		F. Hallman	2,250	1⅔	Bituminous, soft	Do.
	Near Strattonville	James G. Wilson	635	3½	Bituminous	Neighborhood and home.
	Turkey City	James Berry	600	5½	Bituminous; steam	Do
	do	Edinger Bros	456	2½	Bituminous, soft	Do.
	Richland township	Peter Dunn	280	2½	Bituminous	Do.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CLARION CO.—cont'd.			*Feet.*		
.....	Salem township	William Diltman	263	2¼	Bituminous, soft	Neighborhood and home.
.....	Richland township	J. W. Blair	464	4⅝	Bituminous	Do.
.....	West Freedom	J. B. Grazier	390	2	do	Do.
.....	Foxburgh	Thomas Tregoming	857	4	do	Neighborhood.
.....	East Brady	Elder & Bennett	250		do	
.....	Elk City	H. B. Santrock	1,824	2½	do	Do.
.....	West Freedom	Harrison McCall	684	2½	do	Neighborhood and home.
.....	Lamartine	Jacob Kribbs	380		do	Neighborhood.
.....	Salem	Harris Hoas	437		do	Do.
	CLEARFIELD COUNTY.					
Laurel Run mine	Decatur township	John Nuttall & Co	64,587	5½	Bituminous	Harrisburg, Balto., Phila., and N. Y.
Decatur mine	Morris township	do	59,738	4⅝	do	Do.
Morrisdale mine, D seam	Morrisdale Mines	R. Buligton	144,649	4½	do	Eastern Pa., N. Y., and New Eng. states.
Beaver mine, B seam	Near Houtzdale	John Morris & Co	4,838	4½-5	do	Line of Pa. R. R. and Reading R. R.
Leonard mine, Bagshaw seam	Philipsburg	John Ashcroft	8,400	3⅝	do	P. R. R. Co. and P. and R.
Franklin mine, B seam	Houtzdale	Kittanning Coal Co	131,405	4½-5	do	
Moshannon mine, B and D seams.	Moshannon station	Moshannon C. Co	74,508	4-5	do	Line of Penna. and Phila. and Reading R. R.'s and branches.
Excelsior mine, B seam	Houtzdale	Fisher Bros. & Miller	192,000	4⅝	Semi-bituminous	Phila., N. Y., Boston, and R. R. trade of Pa.
Penn mine, B seam	do	Reakut Bros. & Co	35,693	4	Bituminous	Phila., Harrisburg, Boston, etc.
Sterling No. 1 mine, E seam	Sterling	Robt. Hare, Powell & Co.	236,719	5	do	Phila., N. Y., Boston, and steamship lines in New England and Middle states.
Sterling No. 2 mine, E seam	Houtzdale	do	69,650	5½	do	Phila., N. Y., Boston, New England and Middle states.
Ocean mine, B seam	Near Houtzdale	Whitehead & Co	201,600	4½	do	Philadelphia.
Webster mine, B seam	Houtzdale	Webster C. Co., lim	130,121	4½	Semi-bituminous	Penna., N. Y., and New England.
Reading mine, B seam	Osceola Mills	Henry Liveright	21,799	4½	do	Middle and eastern part of Pa.
Goss Run mine	Woodward township	Berwind, White & Co	111,625	5½	do	New Eng. states and ocean steamers.
Eureka mine, E seam	Houtzdale	do	47,997	5½	do	Do.
Mapleton mine	Decatur township	do	50,925	4½	do	Pennsylvania, New England states, and ocean steamers.
.....	Morris township	B. R. Wigton	45,000		Bituminous	Philadelphia.
Hilldrup and Sandy Lick mine.		Sandy Lick Gas C. and Coke Co.	56,048		do	
Rochester mine	Du Bois	Bell, Lewis & Yates	None.		do	
Derby mine	Philipsburg	Thos. Barnes & Bro	28,000	4	do	Do.
.....	Coal mining	Espeh Bros	1,000		do	Osceola Mill, Pa.
.....	do	John Wilkinson	3,000		do	Tyrone, Pa.
.....	do	D. C Burkett	1,000		do	Osceola Mills, Pa.
.....	Penn. township	George Hartshorn	571	4	do	Local trade.
.....	Pike township	James Norris	138	3	do	Curwinsville.
.....	do	George Norris	100	3	do	Do.
.....	Clearfield borough	Lee & Bigler	1,200		do	Home, Clearfield.
.....	Morris township	John Mone	400	4	do	Morris township and neighborhood.
	CLINTON COUNTY.					
.....	East Keating township	Wistar C. and I. Co	328		Bituminous	Local.
.....		Mary Greenough & Co.	100		do	Queen Run brick works.
.....		Frederick Morris	2,400		do	Farrandsville brick works.
	ELK COUNTY.					
Daguscahonda mine, C seam	Daguscahonda	Northwestern Mining and Exchange Co.	110,807	3½	Bituminous; steam	Buffalo and Olean, via Phila. and Erie R. R., Dunkirk, A. Valley and Pitts. R. R., Buffalo and Jamestown R. R., P. and E. R. R., and B., N. Y. and P. R. R.
Glen Mayo mine	Johnsonburg	James H. Mayo & Co	17,000	4	Bituminous, red ash, free-burning; steam.	Erie, Buffalo, Bradford oil regions, and local tracts along P. and E. R. R., via P. and E., Buffalo and S. Western, Erie, Dunkirk, A. Val., Pitts., Buffalo, N. Y., Phila. R. R.
Eureka mine, C seam	Daguscahonda	Daniel Eldridge	30,344	3	Bituminous; steam	Erie and Buffalo, via Dagus. R. R., P. and E. R. R., Phila., Buffalo and N. Y. R. R.
St. Mary's Coal Co.'s mine, B seam.	St. Mary's	St. Mary's Coal Co	88,000	3½	Bituminous, soft	Home, via P. and E. R. R.
Cascade mine, 4-foot seam	do	Kaull & Hall	35,000	4	Bituminous	Buffalo and line of P. and E. R. R., via P. and E. R. R., and Buffalo, N. Y. and Phila. R. R.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	FAYETTE COUNTY.			*Feet.*		
James Rutherford mine	Fayette City	Briggs & Co	10,505	5½	Bituminous	Pittsburgh, via Monongahela river.
Washington mine	Broad Ford	S. Cochran, Sons & Co.	12,958		do	
Globe Works mine	Sherrick's station	A. A. Hutchinson & Bro.	90,000		Bituminous, coking	
Spring Grove Coke Works mine.	Dawson	James Cochran and Sol. Keister.	55,176		Bituminous	
Youngstown mine	Uniontown	Youngstown Coke Co. (limited).	2,485		do	
Connelsville Gas Coke Co.'s mine.	Wheeler	Connelsville Gas and Coke Co.	70,586		do	
Cedar Hill mine, upper and lower seams.	Jefferson township	Morgan & Dixon	25,941	7	do	Pittsburgh and Cincinnati, via Monongahela and Ohio rivers.
Diamond Coke Works mine	McClure station	McClure & Co	37,248		do	
Painter C. and Coke Works mine.	do	do	144,942		do	
Fair Chance Furnace Coke Works mine.		Fair Chance Furnace Co.	10,220		do	
Franklin mine		B. F. Keister & Co	10,000		do	
Mt. Braddock Coke Works mine.		S. Colvin & Co	65,000		do	
Umpire mine	Brownsville	John S. Cunningham & Co.	30,769	6½	do	Pittsburgh, Pa., via Monongahela river.
Turnbull & Hall mine	Turnbull's landing	Jos. Turnbull and John Hall.	62,700	5¾	do	Pittsburgh, Allegheny, and E. Liverpool, Ohio.
	Brownsville	Henry Wilkins	4,886	9	do	Home.
Home Coke Works mine	Eversae	Sherrick & Wiley	15,000	8	Bituminous, coking	
Oliphant Furnace mine Pittsburgh seam.	Oliphant furnace	H. & R. C. Oliphant	8,064	8	do	Furnaces on property.
Lemont Coke Works mine	Lemont Furnace	Hogsett, Hanna & Co	63,350		Bituminous	
Pennsville mine	Pennsville	A. H. Sherrick	33,875		do	
Dexter Coke Works mine		J. R. Stauffer & Co	24,776		do	
Pittsbg. and Connelsville Gas C. and Coke Co's. mine.	Connelsville	Pbg. and Connelsville G., C., and C. Co.	159,903		do	
Morrell & Wickham mine	Near Connelsville	Cambria Iron Co	560		do	
Uniondale Coke Works mine	Dunbar	Reid Bros.	57,750		do	
Henry Clay, Frick, Morgan, Foundery, Eagle, Summit, Anchor, Valley, and Tip Top mines.		H. C. Frick & Co	547,200		Semi-bituminous	
Fountain mine	Fountain mills	A. P. Blake	24,500	9	do	
Deer Park mine	Dunbar	Mahoning Coke Co	55,832		Bituminous	
Hill Farm mine	Near Dunbar	Dunbar Furnace Co	58,500		Bituminous, coking	
Parish Coke Works mine	Ferguson station	do	9,310		do	
Mt. Braddock's C. Wks. mine.		Chas. H. Armstrong & Son.	9,200		Bituminous	
Sterling Works mine	Tyrone	J. M. Schoonmaker	250,000		Bituminous, coking	
Tyrone mine.	Broad Ford	Laughlin & Co	65,558		Bituminous	
	North Union township.	John McFadden	1,000		do	Uniontown.
Chi. & Connellson Coke Co., limited, mine.	Uniontown	Chi. and Coke Connellson Co., limited.	None.		do	
Fort Hill Coke Works mine	Dawson	W. J. Rainey	None.		do	
Jackson mine	do	Jackson Min. Co	28,500	7	do	Pittsburgh and Kittanning, Pa., and Cleveland, Ohio, via B. and O. and C. and R. R. R.
Excelsior mine	Monongahela river	Winnett & Bortner	5,320	6	do	Pittsburgh.
Carondelet mine, river seam	Fayette City	Frazer & Frye	30,696		do	Pittsburgh, via Monongahela river.
Percy mine, Pittsburgh seam.	Dunbar	Percy Min. Co	37,540	8	do	B. and O. R. R., brickyards at Mt. Braddock and Dunbar, and Dunbar furnace, via Fayette Co. branch of B. and O. R. R.
Furnace mine, Connelsville seam.	Everson	Everson, Macrum & Co.	52,417	9	do	Charlotte furnace and Scottdale rolling-mill.
Little Alps mine	Opp. California	Little Alps C. Co., lim.	37,536	5	do	Pittsburgh, Cincinnati, Louisville, and New Orleans, via Monongahela, Ohio, and Miss. rivers.
Tremont mine, 7-foot seam	Belle Vernon	Geo. W. Clarke	22,800	6	do	Pittsburgh, Cincinnati, Madison, Ind., Louisville, New Orleans, via Mon., Ohio, and Miss. rivers.
Garrows' Coal Works mine	Monongahela river	Jos. Garrow	8,269	7	do	Pittsburgh, via Mon. river.
Eldorado mine	Moyer's station	Zuck & Henry	38,285	8	Bituminous, soft, coking	Cleveland, Ohio, via P. R. R., C. & P.
Little Redstone mine, Pittsburgh seam.	Near Fayette City	James Rutherford	10,133	5½	Bituminous, hard	Pittsburgh and Orleans, via Mon. river.
Margaret mine, 9-foot seam	National road	John Snider	3,750	9	Bituminous	Uniontown, Fayette county.
—— Pittsburgh seam	Uniontown	John H. King	3,465	9	do	Do.
	Washington township.	R. C. Schmertz & Co	10,280	6	do	Belle Vernon glass works.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	FAYETTE CO.—cont'd.			*Feet.*		
Bridgeport mine	Bridgeport	M. Crawford	3,000	6	Bituminous	Bridgeport, Brownsville, and surrounding country.
	Belle Vernon	S. F. Jones & Co	1,505	6	do	Belle Vernon and vicinity.
Freeman and Hopwood mine, Connelsville seam.	Monroe	N. H. Black	2,812	9	Bituminous, coking	Uniontown and Monroe.
	Whitsettville	Jesse Stricklin	570	9	Bituminous	Neighborhood and home.
	Buttonwood	Harrison Henshaw	1,456	9	do	Do.
	Brownville	John Hartsock	1,200	9	do	
	Belle Vernon	George Vernon	1,400	9	do	Neighborhood.
	GREENE COUNTY.					
Slippery Rock mine, top and bottom seams.	Franklin township	Robert A. Haskinson	3,800	5	Bituminous	Waynesburgh.
Reese and Bolivar mine		Reese & Bolivar	621	3	do	Neighborhood.
	Gray's landing	William Gray & Sons	1,600	5–9	do	Home.
	Waynesburg	B. F. Sayers	760		do	Neighborhood.
	HUNTINGDON COUNTY.					
Ocean and Howe mine, A and B seams.	Dudley	William H. Sweet & Co.	15,931	3½	Bituminous	Greenwich Point and Phila.
Cumberland mine	Coalmont	do	3,243	3	do	Eastern markets, N. Y., and P..ila.
Robertsdale mine, B and C seams.	Robertsdale	Rock Hill I. & C. Co	121,023	6	Semi-bituminous	Co.'s furnaces, eastern Pa., and N. J.
Carbon mine, Cook seam	Broad Top city	Meors Bros	24,876	4¼	do	N. Y. and Brooklyn.
Mooredale mine, Cook seam	Dudley	Reakut Bro. & Co	19,660	2⅝	do	Phila.
Powelton Plane mine, Burnet seam.	Powelton	Robert H. Powell & Co	22,472	5	do	Phila., N. Y., Boston, New Eng. states, and local trade on R. R.
	INDIANA COUNTY.					
Smith mine, Pittsburgh seam.	Smith station	Robert Smith	8,400	6	Bituminous	Inda., New Florence, Altoona, Black Lick, Pa., and P. R. R Co.
Turner mine, Pittsburgh seam.	do	J. M. Turner	8,400	6	do	Do.
	Near Blairsville	Phillip Stiffey	875	7	Semi-bituminous	Blairsville, Pa.
	do	Isaac Hicks	700	6	do	Do.
	do	Edw. Hicks	525	6	do	Do.
	do	Jacob Kuhn	875	7	do	Do.
	do	Jacob Geary	875	7	do	Do.
	Indiana borough	J. & D. S. W. Shepherd.	700	6	do	Indiana borough.
	do	John S. Agey	525	6	do	Do.
	do	Samuel Shearer	3,500	7	do	Do.
	do	John C. Markle	3,500	7	do	Do.
	Rochester mills	Samuel Lowry	1,050	13	do	Neighborhood.
	do	Samuel Barr	700	10	do	Do.
	Near Black Lick	Black Lick Mfg. Co	7,500	4	do	Fire-brick works of company.
	do	Hugh Rager	3,000	4	do	Do.
	do	Louis Aber	2,000	4	do	Do.
	W. Lebanon	Thomas Smith	720	6	Bituminous	Neighborhood.
	Burrel township	Porter J. Snitner	1,000	6	do	Blairsville.
		Samuel Dixon	400	6	do	Do.
	Armstrong township	Holston Bros	800		do	Home.
	S. Mahoning township	A. Weamer	400	4	do	Country trade.
	JEFFERSON COUNTY.					
Hamilton mine	Reynoldsville	Hamilton Coal Co	53,333	5–6	Bituminous; steam, gas, forge, and coke.	Buffalo, via Emporium over B. and R. R., and Oil City, via A. V. R. R. and B. and L. W. R. R.
Washington mine, Freeport No. 2 seam.	Pancoast	Frank Williams & Co	25,912	5	Bituminous, very free from slate, sulphur, and other impurities; gas and steam.	Buffalo, via A. V. R. R., E. and P. R. R., and B., N. Y. and P. R R.
Pancoast mine, Freeport No. 2 seam.	do	Reynoldsville C. Co	37,336	5	do	Do.
Soldier Run mine, Upper Freeport seam.	Reynoldsville	Powers, Brown & Co	31,656	5	do	Buffalo, Canada, west and intermediate points, via B. and N. Y. and P. R. R., and B. and S. W. R. R., and A. V. R. R.
Bolger mine, A seam	Winslow township	P. F. Bolger	1,261	4⅜	Bituminous, soft	Reynoldsville, Brookville, and Emerickville.
Diamond Coal Co.'s mine	Reynoldsville	Diamond Coal Co	25,800		Bituminous	
	Brookville	Jacob Mineweaser	760	3	Bituminous, soft	Neighborhood.
	Roseville	W. B. Cowan	[illegible]	3	Bituminous	Do.
	Punxsutawney	Wm. G. Campbell	1,050	8	do	Neighborhood and home.
	Brookville	W. A. Watts	760	2½	do	Neighborhood.
	Knox township	David A. Eslaugh	646	4½	do	Neighborhood and home.
	Brookville	Wm. Carberry	570	3	do	Neighborhood.
	Stanton	Wm. Henigon	570	5	Bituminous, hard, no sulphur.	Neighborhood and home.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LAWRENCE COUNTY.			*Feet.*		
Beaver mine	Clinton	Lee & Patterson	43,300	3	Bituminous; steam, gas, and R. R.	Erie, via E. and P. R. R.
Clinton C. Works mine	do	Clinton Coal Co	15,957	3	Bituminous; gas and steam.	Erie, New Castle, Youngstown, Niles, Erie and Pittsburgh, and Ashtabula and Pittsburgh R. R.
Davidson mine, 3-foot seam	Wampum	W. B. Enos	20,000	2¾	Bituminous	New Castle, Youngstown, Sharon, and Erie, via P. and C. R. R., and E. and P. R. R.
Welsh mine, 3-foot seam	do	Wampum C. and I. Co.	39,600	2⅝	do	New Castle, Sharon, Ashtabula, and Youngstown, via E. and P. R. R.
	Neshannock township.	Jas. M. Keast	1,800	3	Bituminous, soft	Teamsters and farmers.
Simpson mine	Coal Town	David Speer & Son	2,284	3⅝	Bituminous	New Castle.
Edinburgh mine	Edinburgh	Mahoning Valley I. Co.	3,521	2½-6½	do	Home.
Bell & Sankey mine	Coal Centre	Bell & Sankey	3,675	4½	do	City use and rolling-mill.
Robt. H. Peeble mine, 4-foot seam.	Neshannock township.	Neshannock C. Co.	15,000	3½	do	New Castle.
Croton mine	Hickory township	Patrick Kennedy	2,940	2½	Bituminous, soft, free from pyrite.	Croton Gap Works and New Castle.
Wallace & McBride mine	W. New Castle	Sharpless & Kincaid	7,883	3	Bituminous, soft	New Castle.
	Peeble farm	Robt. H. Peeble	1,260	3½-4	Bituminous	
	Mount Air	John D. Mitchell	958	6	do	Neighborhood.
	Plain Grove township.	Wm. Bennett	968	3	do	Do.
	East Brook	Sam'l Slater	380	2½	do	Neighborhood and home.
Wallace mine		Sharpless & Kincaid	784	3	do	Neighborhood.
McChesney mine		John Wigley	653	2½	do	Do.
	New Castle	John Wooley	760		do	
	New Bedford	John Waddell	694	3½	do	Do.
Wright mine		S. P. Wright	350	2½	do	Do.
	Neshannock township.	Isaac Smith	1,217	4	do	Do.
	Pulaski	Sam'l English	300	3	do	Neighborhood and home.
	Locust Grove	H. W. Bay	705	3½	do	Neighborhood.
	Coal Town	Alex. McClaren	538	2⅝	do	Do.
	LYCOMING COUNTY.					
Old Red Run mine, B and C seams.	Ralston		None.	6	Semi-bituminous	
McIntyre Co.'s mine, E and B seams.	McIntyre	McIntyre Coal Co	200,923	5½	do	Pa., N. Y. state, Canada, and western states.
	MCKEAN COUNTY.					
Old and Instanter drifts, Barras and Teutonia seams.	Clermont	Buffalo Coal Co	108,173	2-3⅝	Semi-bituminous	Buffalo, McKean and Buff. R. R., Buffalo, N. Y. and Phila. R. R.
Buttsville mine	Buttsville	J. E. Butts, jr	39,205	3½	Bituminous	Carrollton and towns along Bradford branch of Erie R. R. and along Western Division of Erie R. R.
	MERCER COUNTY.					
Stoneborough mine, Kittaning seam.	Stoneborough	Mercer I. and C. Co	77,282	4½	Bituminous	Buffalo, N. Y., Erie, Pa., Cleveland and Ashtabula, Ohio, and oil country, via railroad.
Orangeville mine, Block seam	Pymatuning	Morris Coal Co	16,096	2½	Bituminous, hard	Kent, Salamanca, Oil City, Franklin and Meadville, via P. and O. R. R.
Bethel Coal Co.'s mine	Shenango township	Curtis & Boyer	18,788	3	Bituminous, block	Blast-furnaces in neighborhood, and Erie, Pa., via E. and P. R. R.
Pardoe mine, No. 3 seam	Pardoe	Mercer Min. and Manufacturing Co.	93,000	4⅝	Bituminous	Shenango, N. Y., P. and O. R. R., Cleveland, Erie and Ashtabula, via Shenango and Allegheny R. R., L., E. and W. and M. S. R. R., N. Y. and P. and O., and E. and P. R. R.
Pacific Slope mine	Sharon	W. B. Dunham	25,870	1½	do	Local iron-works connected with mine.
Pierce Frampton mine, Block seam.	Oakland	Oakland Coal Co	10,637	1½-4½	Bituminous, block	Sharpsville, Erie, Pa., and Cleveland, Ohio, via Sharpsville R. R., and E. and P. R. R., and N. Y., P. and O. R. R.
Oakland No. 3 mine, Block seam.	do	do	15,540	1½-4½	do	Do.
Neshannock mine	do	John Phillips & Co	22,900	2⅝	Semi-bituminous, block	Sharpsville and Erie, via Sharpsville R. R. and E. and P. R. R.
Hickory mine, Block seam	Hickory township	Hickory Coal Co	34,480	3⅝	do	Do.
Wise mine	do	Snyder Coal Co	47,400	3½	Bituminous, block	Sharon and Erie, Pa., via Sharpsville and Oakland R. R., and E. and P. R. R.
Rankin mine, Block seam	do	Enoch Filer	2,378	2½-3½	do	Sharon and Erie, Pa.
	North Hickory	F. A. Crawford	600		do	Sharpsville.
Carbon Coal Co.'s mine, No. 1 seam.	Neshannock	A. Parch	4,000	2½	Bituminous, soft	Sharpsville, via Sharpsville R. R.
Laird mine	Shenango township	Thos. Laird	7,290	3	Bituminous, block	West Middlesex.
Home mine	Hickory township	Buhl, Westerman & Co.	15,689	2	do	Erie, via E. and P. R. R.
Hoffman mine	do	Hoffman Bros	3,600	2	do	Sharon.
Wheeler Iron Co.'s mine	Shenango township	Wheeler Iron Co	1,300		do	Own furnace.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	MERCER CO.—cont'd.			*Feet.*		
Duncan C. Co.'s mine	Orangeville	Duncan C. Co	25,800	3½	Bituminous, block	Cleveland, Ohio, Chicago, Ill., and Meadville, Pa.
Hermitage mine, Block seam	Hermitage	Wm. Mottisher	740	2½	do	Sharpsville.
Pine Run mine	do	John Sheddon	1,500	3	do	Do.
Wright mine		J. H. Wright	505	4	Bituminous	Mercer and vicinity.
Bailey Bros. mine, B seam	Sandy lake	Jas. G. and H. B. Bailey	3,300	4½	do	Sandy Lake village and Cochranton and also farmers.
Jackson mine, No. 3 seam	Jackson Centre	Jackson C. Co	32,000	4	do	Ashtabula, via N. F. and L. S. and M. S. R. R's.
	Jay Hill	Jacob and A. M. Zuschlag.	2,906	4	do	Neighborhood, home, and shipped.
	Pini township	Danl. Ross	532	3	do	Home and neighborhood.
	Sharon	Henry Bombeck	800	2	do	Neighborhood.
	Hermitage	Crawford Bros	800	2½	do	Do.
	Transfer	Lyman Carrier	800	3½	do	Neighborhood and shipped.
	Berlin Road	W. S. Huff	700	3	do	Neighborhood.
	Hickory	Henry Holsaffle	3,053	2½	do	Furnaces.
	Crills	Wm. Houston	1,750	4	do	Neighborhood.
	Stony Hill	Chas. Williams	1,000	2¾	do	Do.
	Hickory	Henry Ulrich	450	2½–3½	do	Do.
	Oak Hill	Perry A. Coon	700	3½	do	Do.
Fox mine		John Ebberts	500	4½	do	Do.
		P. H. Ebberts	1,500	4½	do	Neighborhood and home.
	North Liberty	I. W. Denniston	912	3	do	
	Wolf Creek	J. W. Emery	1,000	5	do	
Chestnut Ridge mine		Anton Heilig	3,762	3½	do	Neighborhood.
	Greenville	F. W. Looser	2,000	3–4	Bituminous, block	Do.
	Luckarick	Jas. Thomson	700	5	Bituminous, soft	Mercer.
		Three persons	2,656		Bituminous	
	SOMERSET COUNTY.					
Meyersdale C. Co.'s mine, Pittsburgh seam.	Meyersdale	Meyersdale C. Co	2,800	6–7	do	Balt., Md., via B. and O. R. R.
Salisbury mine	N. Salisbury	C. W. Williams	25,536	9	do	Hagerstown, Fredericktown, and Balt. Md., via B. and O. R. R.
Cumberland mine	N. Myersdale	J. W. Williams	6,379	7½	do	Do.
Balto. and Cumberland mine, Hirsch seam.	Keystone Junction	Adam Kreitzburg	21,504	4	do	Baltimore.
Salisbury Central mine, Pittsburgh seam.	Salisbury	Balto. and Cumberland C. Co. (limited).	17,480	9	do	Do.
Casselman C. Co.'s mine	Garrett	Casselman C. Co	336	3	Semi-bituminous	Baltimore and Cumberland.
Philson I. and C. Co.'s mine, Upper Berlin seam.	Berlin	S. Philson and Cam Krisanger.	3,345	4	Semi-bituminous; domestic, and steam.	Balt. and local trade on B. and O. R. R.
Cumberland and Elk Lick mine.	Meyersdale	Cumb. and Elk Lick C. Co.	110,779	6	do	Do.
Berlin mine	Berlin	B. D. Morgan & Co	9,677	4	do	Phila., Pa., Balto., Md., Wilmington, Del., etc., via B. and O. R. R.
Keystone mine, Pittsburgh seam.	N. Meyersdale	Keystone C. Co	80,640	6½	Semi-bituminous, small amt. of sulphur.	Balt. and Phila., via B. and O. R. R., Penna. R. R.
	Addison township	Liston Bros	455	6	Semi-bituminous	Petersburgh, Somerset county.
	do	Wm. Miller	525	6	do	Do.
	N. Berlin	Jno. Miller	385	8	do	Berlin, Somerset county.
	do	Jacob Musser	490	8	do	Do.
	N. Buckstown	Jacob McGregor	700	7	do	Bedford county.
	do	Andrew Slotter	700	7	do	Do.
	do	Conrad Stoy	700	7	do	Do.
	do	Geo. Lambert	700	7	do	Do.
	Somerset township	Nicholas Berkey	875	7	do	Somerset county.
	do	Rudolph Homer	700	7	do	Do.
	do	Adam Zumpstein	525	7	do	Do.
	do	Jacob Zeigler	525	7	do	Do.
	Elk Lick	Jere Keim	700	10	do	Elk Lick borough.
	TIOGA COUNTY.					
Blossburgh mine	Arnot	Blossburgh C. Co	279,085	6½	Semi-bituminous	N. Y. state principally, Western states, and Canada, via Tioga R. R.
Antrim mine, Bloss. seam	Antrim	Fall Brook C. Co	232,892	4	do	Central part of N. Y. state, via Corning, Cowanesque and Antrim R. R., Syracuse, Geneva and Corning R. R., N. Y. C. and H. R. R. R., and Erie canal.
Fall Brook mine, Bloss. seam	Fall Brook	do	156,490	4	do	Do.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	TIOGA CO.—cont'd.			*Feet.*		
Morris Run mine, Bloss. seam	Morris Run	Morris Run C. Min. Co.	269,380	1⅝–½	Semi-bituminous	Albany, Troy, Utica, Syracuse, Rochester, Buffalo, Auburn, Corning, Geneva, Chicago, and Milwaukee, via T. R. R., C. C. and A. R. R., N. Y. C. and H. R. R., E. R. R., and canal.
Mitchell mine, Bloss. seam	Willson Creek	Albert Dale	610	4	Bituminous	Wellsborough.
Lanark mine, Bloss. seam	Wellsborough	William Boatman and Robert Brownlee.	60	3⅝	Semi-bituminous	Do.
	VENANGO COUNTY.					
Philadelphia mine	Cranberry	James Kennedy	5,916	2½	Bituminous, free from slate, considerable sulphur; steam.	Oil City.
Berringer mine, Limestone seam.	Berringer farm	James T. Dye	684	2½	Bituminous	Bullion oil district.
Maple Grove mine	Raymilton	S. P. McCalmont	11,000	4	do	Franklin, Oil City, and Erie, via L. S. and M. S. R. R., and own road.
McElhinny mine	French Creek township.	Tiel & McDowell	3,522	3½	Bituminous; steam	Franklin and vicinity.
	Clinton township	Samuel Walter	1,000	3	Bituminous	Bullion oil district.
	Irwin	Thomas H. Price	2,000		Bituminous, soft	Vicinity.
	Agnew mills	Piper & Bro	1,291	2½	Bituminous	Neighborhood.
	Cranberry	J. P. Steffey	380	2½	do	Neighborhood and home.
	WASHINGTON COUNTY.					
Laurel Hill mine	N. McDonald	W. P. Rend & Co	47,928	4½	Bituminous	Chicago, Ill., via P. C. and St. L. R. R.
Midway Block C. Co.'s mine	Midway	G. W. Crawford & Co	13,995	4½	Bituminous, block	Chicago and the lakes, via P. C. and St. L. R. R.
Cincinnati mine	Coal Bluff	J. S. Neel	41,172	5	Bituminous	Cincinnati and Louisville.
Black Hill mine	Union township	Heyser & Co., lim	8,069	4½	do	Mills and vicinity, and Chicago, Toledo, and Ohio, via Div. of P. M. M., also via Brinton to East Liberty and Ohio.
Cliff mine, Pittsburgh seam	White Mills station	Scully & Co	68,200	5	Bituminous; gas	Pittsburgh, Cleveland, Chicago, and all lower river towns, via Pa. R. R. and branches, and Mon. and Ohio rivers.
Keystone C. Co.'s mine, Pittsburgh seam.	Hanlin	Keystone C. Co., lim	None.	4–4½	Bituminous	Via Ohio river and P. C. and St. L. R. R.
American C. Works mine	Wood's Run	F. H. Coursin	19,000	7½	do	Pittsburgh, Cincinnati, Louisville, Ky., New Orleans, and Alabama, via Mon., Ohio, and Miss. rivers.
Banner Works mine, River seam.	White Mills station	James H. Gamble and J. M. Risher.	37,500	4½	do	Cincinnati and Louisville, Ky.
Allison mine	Chartier's township	Jno. Allison	31,900	5½	Bituminous; gas and steam	Washington and Chicago, Ill., via P. C. and St. L. R. R.
Walnut Hill mine	Midway	Robbins & Arnot	42,717	3½–5	Bituminous, block; gas and steam.	Chicago, Cincinnati, Xenia, and Columbus, via P. C. and St. L. R. R.
Enterprise C. Works mine, Pittsburgh seam.	Washington	V. Harding	12,570	4½	Bituminous; gas	Washington, Waynesburgh, and along lines of B. and O. R. R., and Waynesburgh and Washington R. R., and Chicago, Ill., via P. S. R. R., N. W. R. R., and B. and O. R. R.
Burr Hill mine, Pittsburgh seam.	McDonald	J. D. Santers	18,516	4½	Bituminous	Chicago, Indp., and northern Ind., via P. C. and St. L. R. R
Robbin's mine, Block seam	Midway	Robbin's Block C. Co.	60,274	3½–5	Bituminous; fuel, steam, and gas.	Columbus, Logansport, Bradford Junction, and Indp., via P. C. and St. L. R. R.
Shire Oak mine, Youghigheny seam.	Shire Oak	Blackburn & Mort	34,200	4½	Bituminous	Cincinnati, Louisville, and New Orleans, via Mon., Ohio, and Miss. rivers.
Knob mine	West Brownsville	S. H. Pearsall & Co	18,966	6	do	Pittsburgh, Cincinnati, Louisville, and New Orleans, via Monongahela and Ohio rivers.
Legler's Valley mine, River seam.	Finleyville	Jacob Legler	4,560	5	do	Washington, Pa., and Wheeling, W. Va., via P. S. R. R. and P. and O. R. R.
T. J. Wood mine	Allen township	T. J. Wood	26,650	7	do	Pittsburgh, Cincinnati, Louisville, and New Orleans, via Monongahela, Ohio, and Mississippi rivers.
Wellington mine	Wood's Run	R. Wellington	7,600	7	do	Pittsburgh, Pa., via Monongahela river.
Globe mine	California	Crowthus, Musgrave & Co.	73,140	7½	do	Pittsburgh and Ohio river, via Monongahela river.
Courtney mine	Courtney Station	Berry, Cook & Co	16,872	4⅝	do	Pittsburgh and Ohio, via P., F. and W. and C. R. R. and E. and P. R. R.
Coal Bluff mine, Pittsburgh seam.	Coal Bluff	Patterson & Co	56,640	4½	do	West and northwest to Indiana, Ohio, Illinois, Wisconsin, and Minnesota, via P., F. W. and C. R. R., P. C. and and S. and L. R. R.
Warne mine	Monongahela City	H. A. Warne & Co	17,116	4½	do	Pittsburgh, via Monongahela river.
S. R. Cook mine	Chartiers township	James G. Shearn	550	4½	Bituminous, lump and slack.	Cannonsburgh and vicinity and Chicago.
Locust Grove C. and Lime Works.	Cannonsburgh	W. S. White & Son	3,967	4⅝	Bituminous	Local.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WASHINGTON CO.—continued.			*Feet.*		
Evans mine	Evansburgh	W. H. Evans	4,200	4¾	Bituminous	Chicago, Washington, Pa., and Cannonsburgh.
Cannonsburgh C. Works, Bench seam.	Cannonsburgh	K. V. H. Cook	1,900	5	do	Local and western.
Greenfield C. Works	Greenfield	I. S. Neel	65,000	7	do	Pittsburgh, Cincinnati, and Louisville, via Monongahela and Ohio rivers.
Harlem mine, River seam	Harlem	Louis Staile	16,114	4½	do	Cincinnati.
Abe Hays mine, River seam	Monongahela City	W. S. B. Hays	22,751	4⅝–5	Bituminous; gas and blacksmithing.	Pittsburgh, Cincinnati, Louisville, and New Orleans.
Black Diamond mine, River seam.	Black Diamond	Louis Staile	42,491	4½	Bituminous; gas	Cincinnati, Saint Louis, and all river towns to New Orleans.
Buffalo mine, Pittsburgh seam.	Limetown	J. W. Ellsworth and J. J. Steutler.	None.	4½	Bituminous	Indiana, Illinois, Minnesota, Iowa, and other western and northern states, via P. C. and St. L. R. R.
Catsburgh mine	Monongahela City	Louis Staile	None.		do	
New Eagle mine	do	Lindsay & M'Cutcheon	29,647		do	Pittsburgh, Cincinnati, Louisville, and New Orleans, via river and P. and C. R. R.; also own rolling-mill.
Elizabeth C. Co. mine	Carroll township	Elizabeth C. Co., lim	19,069	4½	Bituminous, soft	Pittsburgh, Cincinnati, and Louisville, via Monongahela and Ohio rivers.
Twilight mine	Twilight	Charles Huske	180	6	Bituminous	Home.
Clipper C. Works	Allenport	E. C. Furlong	30,991	7	do	Pittsburgh, via Monongahela river.
Huston C. Works	Limetown	John T. Huston & Co.	10,260	5	do	Down river, Cincinnati, etc. via Ohio river.
Champion mine, Upper and Lower seams.	Wood's Run	Morgan & Dixon	26,286	7	do	Pittsburgh and Cincinnati, Ohio, via Monongahela and Ohio rivers.
Smith mine	Pike Run	Moore & Smith	22,780		do	Ohio river markets, via Monongahela and Ohio rivers.
	Arden	Fred. Marshall	800	4½	Bituminous, soft	Neighborhood.
	Burgettstown	Stevenavit	1,140	5	Bituminous	Do.
	Pike Run	George Siddell	760	9	Bituminous	Neighborhood.
	Hanlin	Jos. Ferguson	800	5	do	Do.
	Lone Pine	H. M. Walton	570	3	do	Do.
	do	Amos Wise	456	3	do	Do.
	Monongahela city	Jos. Kennedy	1,140	4	do	Do.
	McComb's station	Robt. McComb	950	5	do	Do.
	Monongahela city	Isaac S. Keeny	950	5	do	Do.
	Fredericktown	Louis Phillips	950	7	do	Neighborhood and home.
	Burgettstown	John Andrews	950		do	Neighborhood.
	Greenfield	Saml. Keatlr	1,520	7	Semi-bituminous	Do.
	Ewing station	J. H. Ewing	1,575		Bituminous	Neighborhood and home.
	E. Bethlehem twp	B. F. Hawthorne	800		do	Neighborhood.
	WESTMORELAND COUNTY.					
Millwood mine, Pittsburgh seam.	Millwood	Millwood C. and Coke Co.	91,146	5	Semi-bituminous	Penna. R. R. Co.
Bessemer Coke Works mine.		C. P. Markle and Sons.	45,888		Bituminous	
Hazlet C. and Coke Works mine.	Mullen's station	Boyle and Rafferty	181,710		do	
Armstrong mine, Yohogany seam.	Armstrong station	C. H. Armstrong	44,080	4 1/12	do	Pittsburgh, via B. and O. R. R.
Amieville mine	Amieville	N. I. Bigley	48,000	5	do	Baltimore, Md., Pittsburgh, Pa., and intermediate points, via B. and O. R. R.
Loyal Hanna mine, Connellsville seam.	Latrobe	Loyal Hanna C. and Coke Co.	118,191	6½	do	Mostly coked, also W. Va. and Pa. R. R.
Apollo Iron Works mine		Laufman & Co	16,386	3½	Bituminous; iron mfg	Own use.
Youghiogheny Gas C. Co. mine.	W. Newton	Youghiogheny Gas C. Co.	32,460	6	Bituminous, gas	Balt., Md., and Pittsburgh Pa., via B. and O. R. R.
White Ball mine, Pittsburgh seam.	Yohoghany	McCandless, King & Co.	38,080	5½	do	N. Eng. States and N. Y. State.
Shafton mine, Pittsburgh seam.	Shafton	Shafton Coal Co.	19,600	5	do	Pa. R. R. Co.
Shaft No. 1, Pittsburgh seam.	Irwin	Penn. Gas Coal Co	180,604	5	do	N. E., N. Y., N. J., Pa., South, Mexico and Cuba, via Pa. R. R. and B. and O. R. R.
Shaft No. 2, Pittsburgh seam.	do	do	159,905	5	do	Do.
Irwin, Southside, Larimer, 1 and 2, Fisher, Westm'd, and Spring Hill mines, Pittsburgh seam.	Penna. to Larimer Sta., on P. R. R.	Westmoreland C. Co	534,626	5	Bituminous	Atlantic cities by R. R. to tide-water, also beyond by C., incl. export to Cuba and Brazil.
Jones & Watkins mine	Crumbies	Jones & Watkins	13,751	5	do	Cincinnati and Louisville, via Ohio river.
Ocean mine, second seam	Scott Haven	W. L. Scott & Co	152,000	5	Bituminous; gas	Erie, Pa., and Baltimore, Md., via Pa. R. R. and B. and O. R. R.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WESTMORELAND CO.—continued.			*Feet.*		
Eureka mine	Jacob's creek	Fox, Kifer & Aspey	24,890	8½	Bituminous; gas and coking	Baltimore, Md., Pittsburgh and Youngstown, Ohio, via P. and O. R. R. and P. and L. E. R. R.
Iron City mine	Webster	Phillips & Mittenzney	22,800	5	Bituminous; domestic and manufacturing.	Cincinnati and Louisville, via Ohio river.
Union Gas C. Works mine	do	Jacob Tower, jr	13,870	4½	Bituminous	Pittsburgh, Cincinnati, Louisville, via Ohio and Monongahela rivers.
North Webster mine	do	John Gilmore	50,897	4½	do	Cincinnati, Pittsburgh, Louisville, Evansville, Cairo, Nashville, Saint Louis, Memphis, and New Orleans, via Monongahela and Ohio rivers.
SW. Coal Co., limited, mine, Connelsville seam.	Tarrs	SW. C. Co., limited	36,000	4	Bituminous; coking	Pa. R. R. Co., rolling-mill works, and domestic use, via Pa. R. R. and branches.
Lichburg mine	Near Lichburg	D. B. Ashbaugh	81,050	4	Bituminous	Altoona, Harrisburg, Millheim, Louistown, and Mantua, via W. R. R. and Pa. R. R.
Saltburgh mine, 7-foot seam.	Saltburgh	Saltburgh Coal Co	78,325	7	Bituminous, block	Pa. R. R. Co.
M. Saxman, jr., & Co.'s mine, Pittsburgh seam.	Latrobe	M. Saxman, jr., & Co	60,000	7	Bituminous	Eastern markets along Pa. R. R.
Webster Coal Co.'s mine, Pittsburgh seam.	Webster	John & W. C. Guffey	12,105	4½	Bituminous; gas	Pittsburgh, Cincinnati, and Louisville, via Monongahela and Ohio rivers.
Markle Coal Works mine, 6-foot seam.	Junction City	C. P. Markle & Sons	9,226	5½	Bituminous	Own use at West Newton paper-mills, via B. and O. R. R.
Saxman mine, top and bottom seams.	Near Latrobe	D. J. Saxman	1,440	9	do	Latrobe and vicinity.
——, 9-foot seam	Scottdale	W. A. Kifer	18,240	8	do	Scottdale.
J. Saxman mine	Latrobe	H. C. Best	2,400	6	do	Latrobe.
Mary Long mine, Main seam.	Hempfield	P. S. Kuhn	3,504	7	do	
	Hempfield township	John D. Miller	1,024	7	do	Greensburgh and vicinity.
Rostraver mine	Rostraver	Abraham Rupert	38,000	5	do	Cincinnati, Ohio, Madison, Ind., via Monongahela and Ohio rivers.
No. 4 mine, Pittsburgh seam	Sewickley station	Penna. Gas C. Co	202,691	5	do	New England, New York, New Jersey, Pennsylvania, Southern Mexico, and Cuba, via Pa. R. R. and B. and O. R. R.
Coal Run mine, Pittsburgh seam.	Irwin	do	182,845	5	do	Do.
Greensburgh mine, 7-foot seam.	Greensburgh	Greensburgh C. Co	28,100	7	do	Via Pa. R. R. and S. W. branch.
Waverly Coal and Coke Co.'s mine.	Suntleton	Waverly C. and Coke Co.	80,000	8	do	New York and New England ports, and West, via B. and O. R. R., P. and L. E. R. R., and Pa. R. R.
American Coke Works mine.	Stonersville	Samuel Warden & Co	20,441		do	
Standard mine	Mount Pleasant	A. A. Hutchinson & Bro.	150,000		do	
W. Overton mine	W. Overton	A. C. Overholt & Co	63,000		do	
Union Coke Works mine	Stoners	Hurst, Stoner & Co	73,064		do	
Star mine	Stauffer	B. F. Coughenour	12,500		do	
Isabella Coke works mine	Cokeville	Isabella Furnace Co	96,000		do	
Rising Sun Coke works mine.	Mount Pleasant	Markle & Co	45,429		do	
Mullin mine	Bridgeport	H. C. Frick & Co	35,600		Semi-bituminous	
Buckeye mine	Mount Pleasant	J. M. Cochran	60,299		Bituminous	
Morewood mine	do	Morewood Coke Co	29,850		Semi-bituminous	
Alice mine	do	J. M. Schoonmaker	None.		Bituminous	
Monastery mine	Latrobe	Edgar Thompson Steel Co.	10,000	8	do	Western points
Emma mine	Mount Pleasant	J. W. Overholt	22,248		do	
Enterprise Coke works mine.	Tarrs	Dillinger & Rafferty	27,360		do	
	Bolivar	Reese, Hammond & Co	2,000	5	Bituminous, soft	Home.
	Burrell	Henry Ellerman & Co.	1,330	4½	Bituminous	Do.
	New Salem	Henry Hugns	673	7	do	Neighborhood.
	Greensburgh	Robert Lowry	1,312	7	do	Do.
	Larimer station	Adam Robb	456	5	do	Neighborhood and home.
	Latrobe	E. J. Reed	1,710	6½	do	Neighborhood.
	Pennsylvania twp	Steiner & Walton	729	6	do	Do.
	Manor	John Sowash	698	6	Bituminous; gas	Neighborhood and home.
	Bolivar	Murtland & Scott	2,090	6	Bituminous	Do.
	Franklin township	John Stewart	950	6	do	Do.
	Merwin	John Hunter	520	6	do	Neighborhood.
	Paintersville station	J. H. King	2,625	4½	do	Home.
	Pleasant Unity	William Wright	760	8	Bituminous; coking	Neighborhood.
	Coal Hill	Paul Peterson	608	7	Bituminous	Do.
	Tarrs' station	Henry H. Tarrs	1,520	9	do	Do.
	Pinkerton	John Pinkerton	1,140	8	Bituminous; gas	Do.
	Youngstown	Horbach heirs and J. B. Anderson.	700	9	Bituminous	Do.

Directory of bituminous coal mines—Continued.

PENNSYLVANIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	WESTMORELAND CO.—continued.			*Feet.*		
.....	Lockport station	Gardner Bros	1,683	5	Bituminous	Neighborhood and home.
.....	Greensburgh	J. C. McCausland	1,026	7	do	Neighborhood.
.....	Murrysville	O. M. Haymaker & Bro.	760	.....	do	Do.
.....	Mount Pleasant	R. K. Hisson	532	.....	do	Do.
.....	Beatty station	Saint Vincent Abbey	1,520	8	do	Home.
.....	Greensburgh	John Rugh	768	7	do	Neighborhood and home.
.....	Pleasant Unity	George Chambers	800	9	Bituminous; coking	Do.
.....	Adamsburgh	Adam Kemerer	855	5	Bituminous	Neighborhood.

TENNESSEE.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	ANDERSON COUNTY.					
Black Diamond mine, E seam.	Coal Creek	Black Diamond C. Co.	18,000	4½–5	Bituminous	Knoxville, Atlanta, and other points in Tennessee and Georgia.
Weldon mine, E seam	do	E. Tenn. Coal Co	1,400	4½–5	do	Knoxville, etc.
Central C. Co.'s mine, E seam.	do	Central Coal Co	15,000	4½–5	do	Knoxville, Atlanta, Chattanooga, Bristol, and intermediate points, via K. and O. R. R., E. T., V. and G. R. R., and W. and A. R. R.
Knoxville Iron Co.'s mine	do	Knoxville Iron Co	96,918	5½–6	do	Chattanooga, Atlanta, intermediate points, Bristol and line of A. M. and O. R. R., and Knoxville, via K. and O. R. R. and E. T., V. and G. R. R.
E. Tenn. Coal Co.'s mine	do	E. Tenn. Coal Co	3,500	4½	Bituminous, hard	Knoxville and other towns in Tenn., Dalton, Marrietta, Atlanta, Athens, Macon, Augusta, Columbia, and Rome, via K. and O. R. R., E. T., V. and G. R. R., W. and A. R. R., M. and C. R. R.
Franklin Coal Co.'s mine	.....	.....	None.	.....	Bituminous	
Enterprise Coal Co.'s mine	.....	.....	None.	.....	do	
Coal Creek Coal Co.'s mine	Coal Creek	Coal Creek Coal Co	None.	5	Semi-bituminous	Tenn., Ga., Ala., S. C., and Va.
Anderson County Coal Co.'s mine, 5-foot seam.	do	Coal Creek Coal Co. and O. P. Temple.	6,000	4½	Bituminous	Do.
	CAMPBELL COUNTY.					
Campbell Co. mine	Caryville	H. P. Stone	1,200	2½–3½	Bituminous; gas	Knoxville and Atlanta.
	CUMBERLAND COUNTY.					
Brown mine	Crossville	G. W. Brown	24	7	Bituminous, hard	Crossville and blacksmiths of vicinity.
	FRANKLIN COUNTY.					
University mine, University seam.	Sewanee	University Coal Co	1,000	2	Bituminous, laminated, free-burning, hard.	Sewanee, Shelbyville, Fayetteville, and Winchester.
Shake Rag mine, Shake Rag seam.	do	do	275	2	do	Do.
Anderson mine, Cliff seam	Anderson	Thomas J. Johns	50	3	Bituminous, hard, red ash, free-burning.	Nashville, Chattanooga, Memphis, Atlanta, Macon, Columbus, Augusta, Savannah, and Port Royal.
	GRUNDY COUNTY.					
Sewanee mine, Sewanee seam.	Tracy City	Tenn. C. and R. R. Co	200,000	4	Semi-bituminous, coking, soft, friable, free from sulphur.	Atlanta, Rome, Chattanooga, Nashville, St. Louis, via R. R.
	HAMILTON COUNTY.					
Soddy mine, Nos. 7, 9, and 10 seams.	Soddy	Soddy Coal Co	50,000	8½	Semi-bituminous	Chattanooga, Atlanta, and all principal southern cities.
Hamilton mine	Melville	Thomas Parker	None.	3½	Bituminous, hard, free from pyrite and other impurities.	Chattanooga and points south.
	MARION COUNTY.					
Etna mine, Kelly seam	Whiteside	D. B. Pillsbury	18,000	2½–2¾	Semi-bituminous	All over the south, and some to Inda., via N. C. and St. L. R. R. and connections
Victoria mine, Sewanee seam.	.....	S. S. C. I. and L. Co	17,939	2½–3	Bituminous	Home.
Battle Creek mine, Battle Creek seam.	Battle Creek	.....	6,560	1⅝	Bituminous, irregular-block.	Nashville, Chatt., and intermediate places.
.....	.....	Jacob Houtz	300	2	Bituminous	Decatur, Ala.
.....	.....	David McNabb	325	2	do	Do.
	ROANE COUNTY.					
Roane Iron Co.'s mine, Rockwood seam.	Rockwood	Roane Iron Co	56,000	5	Semi-bituminous	All used in furnace.
Oakdale I. Works' mine	Oakdale	Oakdale I. Works	None.	2–3	Bituminous; furnaces and smelting iron.	
	WHITE COUNTY.					
Little Brice mine, Brown & Little seam.	Sparta	William Hodge	2,000	3½–4½	Bituminous	Sparta, Tenn.

Directory of bituminous coal mines—Continued.

VIRGINIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	CHESTERFIELD COUNTY.			*Feet.*		
Bright Hope mine, Top, middle, and bottom seams.	Clover Hill	Bright Hope R. Co	19,040	27-30	Bituminous	Richmond, Petersburgh, Norfolk, Va., and tide-water cities on Atlantic coast.
Cunliff mine	Coalfield	Geo. H. & Jno. Jewett	6,720	25	do	Richmond, Va.
Union mine	Midlothian	Jacob Baach	1,638	8	do	Do.
Midlothian mine	do	R. S. Burrows	13,122	4⅔	do	Richmond and Manchester.

WASHINGTON TERRITORY.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	KING COUNTY.					
Seattle C. and Transp. Co.'s mine, Nos. 2, 3, 4, and 5, Bagley, 7-ft, and Alsworth seams.	10 miles from Seattle	Seattle C. and Transp. Co.	138,764	71	Lignite, hard, bright, non-coking.	San Francisco, Cal.
Old Talbot & Reuton mine, Upper and lower Old and New Talbot seams.	13 miles southeast of Seattle.	Reuton C. Co	3,339	48½	Lignite	San Francisco and Seattle.
	PIERCE COUNTY.					
Wilkeson mine, Ainsworth & Wright seam.	31 miles southeast of New Tacoma.	A co-operative company.	261	19	Bituminous, coking; blacksmithing.	New Tacoma.
	THURSTON COUNTY.					
Thurston C. Co's mine	Four miles from Tenino	Thurston C. Co	2,651	2½	Lignite, non-coking	Portland, Or., and Olympia, Washington Ter.

WEST VIRGINIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	BARBOUR COUNTY.					
	Philippi	Lewis Wilson	950	5	Semi-bituminous	Philippi.
	BOONE COUNTY.					
Peytona Cannel C. Co.'s mine, Cannel seam.	Peytona	Peytona Cannel C. Co	22,400	1⅓	Cannel	St. Louis, Cincinnati, and New York, via Kana. and Ohio rivers, Chesapeake and O. R. R., and by sea.
	BROOKE COUNTY.					
	Middle Ferry	Nathaniel Wells	2,280	5	Semi-bituminous	Steamboats on Ohio river.
	Bethany Dist	Thos. Henderson	760	5	do	Bethany and vicinity.
	do	Jno. E. Curtis	950	5	do	Do.
	do	Jas. E. Councilman	684	5	do	Do.
	do	Alex. Campbell	665	5	do	Do.
	Short Run	Robt. Young	3,800	5	do	Steamboats on Ohio river.
	do	John Bowman	4,560	5	do	Do.
	Lazearville	Jos. Thompson	5,700	5	do	Wellsburgh, Lazearville, and vicinity.
	do	Henry G. Lazear	7,600	5	do	Wellsburg and other places along R. R.
	Wellsburgh	Forbes, Carmichael & Co.	9,500	5	do	Wellsburg and other places along Ohio river.
	DODDRIDGE COUNTY.					
	West Union	Jos. Chevraunt	760	4	Semi-bituminous	West Union.
	FAYETTE COUNTY.					
Faulkner mine, Kanawha seam.	Frederick	Fred. K. Faulkner	44,800	5⅝	Bituminous; gas and steam	N. Y., Phila., Richmond and Cin., via Ches. and O. R. R., and Kanawha and Ohio rivers.
Nuttallburgh mine	Nuttallburgh	John Nuttall	56,000	3⅓	Bituminous, coking; steamships.	Richmond and Cin., via C. and O. R. R.
Eureka mine, Gas seam	Coal Valley	Eureka C. Co	10,363	6	Bituminous; gas	Ches. and Ohio R. R.
Coal Valley C. Co.'s mine, Gas and Splint seams.	do	A. T. Toman	15,878	6½	Bituminous, splint or block	Richmond, Va., N. Y., and other eastern cities, also Balt., via C. and O. R. R.
Gauley Mt. mine, Gauley Mt. seam.	Ansted	Hawks Nest C. Co., lim	24,417	11	Bituminous, soft, coking	Boston, N. Y., Portland, Me., and Richmond, Va., via C. and O. R. R., James riv., the Atlantic, and Ohio river.
Fire Creek mine, Fire Creek seam.	Fire Creek	Fire Cr. C. and Coke Co.	20,209	3-4	Semi-bituminous, red ash	N. Y., Boston, Phila., Norfolk, Richmond, Petersburgh, Lynchburgh, and local points on C and O. R. R., Cincinnati, Louisville, and other western markets, via C. and O. R. R.
Elm mine, Sewell seam	Elm Station	Beury, Cooper & Williams.	11,200	4-4½	Semi-bituminous, coking	C. and O. Coal Agency, Va., and Low Moor Iron Co.
Eagle mine, Eagle seam	Eagle	Stone & Wyant	24,640	4½	Bituminous	Cin. C. and O. R. R. Co. and local points, via C. and O. R. R.
Hawk's Nest mine, Fire Creek seam.	Hawk's Nest	New River C. and Coke Co.	6,720	2⅔-3⅓	do	Richmond, Va., via C. and O. R. R.

Directory of bituminous coal mines—Continued.

WEST VIRGINIA.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	FAYETTE CO.—cont'd.			*Feet.*		
Crescent mine, Coal Valley seam.	Crescent	W. R. Johnson	50,400	6½	Bituminous, gas, and splint	Cincinnati, Newton, Huntingdon, Richmond, Lynchburgh, Danville, N. Y., and New England states.
Quinnimont mine, Quinnimont seam.	Quinnimont	Pa. and Va. C. and I. Co.	44,800	3	Semi-bituminous	Local coke ovens.
Cedar Grove C. Co.'s mine			None.		Bituminous	
Fayette C. and Coke Co.'s mine			None.		do	
Longdale Iron Co.'s mine	Sewell	Longdale Iron Co	15,450		do	
Pine-Top mine	2 miles northeast of Fayette C. H.	Connell & McDonald	800	3½	do	Most at Fayetteville.
	GRANT COUNTY.					
	Williamsport	F. A. Nydigger	350	8	Bituminous	Williamsport.
	Luney's Creek	Andrew J. Ankeny	420	6	Semi-bituminous	Luney's Creek.
	HANCOCK COUNTY.					
	New Cumberland	Reuben Hobbs	7,600	3½	Bituminous	Steamboats on Ohio river.
	do	Samuel G. Hineman	5,700	3½	do	New Cumberland.
	do	Geo. W. Dairs	1,140	3½	do	Do.
	do	Fred Myers	760	3½	do	Do.
	Fairview	Philip Dawson	380	3½	Semi-bituminous	Fairview and vicinity.
	do	Robt. Miller	570	3½	do	Do.
	do	Wm. S. Matthews	3,800	3½	do	Factories of Fairview.
	HARRISON COUNTY.					
Monongahela Gas Coal mine	Wilsonburgh	H. G. Davis	22,400	8½	Bituminous; gas	B. and O. R. R. Co. and a few local points.
Harrison Co. C. Co. mine	Clarksburgh	Harrison Co. C. Co	29,382	9	do	Parkersburgh, Chicago, and line of B. and O. R. R.
Murphy Run mine	do	Executors of Burr Wakeman.	16,800	8½	do	New York city, Washington, and Annapolis.
Despard mine, Gas seam	do	Despard C. Co	43,959	9	do	Baltimore and other points along B. and O. R. R.
Farland Gas C. Co.'s mine	do	J. T. Farland	14,560	9	do	Chicago and other western points.
Patrick Dolan mine	Wolf Summit	Patrick Dolan	1,000	7	do	B. and O. R. R. Co.
Luther M. Patton mine	Clarksburgh	Luther M. Patton	1,800	9	do	Clarksburgh.
	do	Jackson & Camden	1,600	9	Bituminous, gas	Do.
	do	Thos. S. Finnell	700	9	do	Do.
	KANAWHA COUNTY.					
Coalburg mine, Coalburg seam.	Coalburg	Robinson C. Co	71,680	4–4½	Bituminous, hard, splint	New York, Richmond, and Cincinnati, via R. R., Kanawha and Ohio rivers.
Robinson Cedar Grove mine, Blacksburg seam.	Cedar Grove	do	500	3¾–4	Bituminous, soft; gas, steam, and blacksmithing.	Cincinnati, via barges and Great Kanawha and Ohio rivers.
Campbell's Creek C. and Oil Co.'s mine, Campbell's Creek seam.	Malden	Campbell's C. and Oil Co.	100,000	5	Bituminous, white ash	Cincinnati and Covington, Ky., in cerior of Ohio and Ky., via Great Kanawha and Ohio rivers and R. R.
Kanawha C. Co.'s mine, Coal Valley seam.	Morris creek	Kanawha C. Co	6,552	5	Bituminous, soft; gas and steam.	Richmond, Va., along line of C. and O. R. R. and Cincinnati, via C. and O. R. R. and Ohio river.
Pioneer mine, Campbell's Creek seam.	Campbell's creek	Pioneer C. Co	64,360	5½	Semi-cannel	Cincinnati, Ohio, via Narrow Gauge R. R. and Kanawha and Ohio rivers.
Bennington mine, Bennington seam.	London district	W. S. Carkin	11,225	3	Bituminous, soft	Cincinnati, via Kanawha and Ohio rivers.
Snow Hill mine, Coalburg seam.	Snow Hill	Snow Hill Salt Co	10,000	4	Bituminous, hard	Snow Hill salt-furnace.
East Bank mine, Coalburg seam.	Coalburg	Stuart M. Buck	20,682	3	Bituminous, splint	Cincinnati, Huntingdon, Richmond, James River, Petersburg, Lynchburg, and Charlotteville, via C. and O. R. R.
Campbell's Creek mine, Campbell's Creek seam.	Malden	Dana Bros	10,000	6½	Bituminous, splint, and semi-cannel.	Cincinnati and Louisville, via Kanawha and Ohio rivers.
Cannelton mine, No. 4 seam	Cannelton	Cannelton C. Co	34,358	2½	Cannel	New York and other Atlantic coast cities, via C. and O. R. R. and vessels.
Dickinsons mine, Campbell's Creek seam.	Dickinsons	J. I. Dickinsons	6,400	5	Bituminous	Salt works at mine.
Splint Coal mine, Pt. Diam. seam.	Splint Coal, est	Splint C. Co	None.	2½	Bituminous, splint; salt-making.	Do.
Dana Bro.'s mine, Campbell's Creek seam.	Campbell's creek	Dana Bros	8,000	6	Bituminous	Cincinnati.
Peabody mine, Peabody seam	Opposite Coalburg	Peabody Coal Co	800	3	do	Kanawha and Ohio river valleys
Dan'l Boone or Brooks mine, Brooks seam.	Breamville	Breamville Salt Co	20,000	4½	Bituminous, splint	Kanawha valley, Cincinnati, Own Salt-Works, and Charleston, W. Va.
Mount Morris C. Co.'s mine	Morris creek	Mount Morris C. Co	4,284	5¾	Bituminous	Richmond, Cincinnati, and Lower Ohio, via C. and O. R. R., James river, seaboard, and Ohio river.

Directory of bituminous coal mines—Continued.

WEST VIRGINIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	LEWIS COUNTY.			Feet.		
	Weston	Jacob Acheson	525	6	Semi-bituminous	Weston.
	do	Richard Barett	630	6	do	Do.
	Hacker's Creek dist	Nathan Bush	525	7	do	Gaston.
	MARION COUNTY.					
Central Gas mine, 9-foot seam.	Fairmont	Oliver Jackson	6,784	8	Semi-bituminous; gas	Local points on B. and O. R. R., Chicago, Ill., Tiffin and Newark, Ohio.
Palatine mine, 9 foot seam	Near Palatine	Newburg Orrel Coal Co.	24,765	7	Bituminous; gas	Baltimore and other points along B. and O. R. R., also B. and O. R. R. Co.
Gaston mine, 9-foot seam	Near Fairmont	Gaston Gas-Coal Co	24,627	8	do	Baltimore, Washington City, Chicago, Saint Louis, and other western points.
W. Fairmont and M. Con. Gas Coal Co.'s mine.	Fairmont	W. Fairmont and M. Con. Gas Coal Co.	3,500	7½	do	Balt. and N. Y.
	Worthington	William J. Bryant	796	9	do	Worthington.
	Riversville	Austin Merrill	700	6	Bituminous	Riversville.
	Palatine	Thomas H. Barnes	1,706	9	Bituminous; gas	Palatine.
	do	John F. Stroud	1,456	9	do	Do.
	do	George Adams	749	9	do	Do.
	Fairmont	Beeson & Rhehart	1,792	9	Bituminous	Fairmont.
	do	William Gaskill	1,278	9	do	Do.
	do	Elmer Hamilton	1,043	9	do	Do.
	do	Matthew L. Fleming	885	9	do	Do.
	do	Hamilton Barnes	718	9	do	Do.
	Fairview	Morgan & Co	875	6	do	Fairview.
	Barrackville	William McCray	700	6	do	Barrackville.
	MARSHALL COUNTY.					
Boggs Run mine	Boggs Run	Boggs Run Min. Co	24,587	5½	Bituminous	B. and O. R. R. Co., Wheeling.
Benwood Coal Works mine	Benwood	Benwood Coal Works	7,520	5	do	Benwood and Wheeling, and points along B. and O. R. R.
Benwood Iron Works mine		Benwood Iron Works	27,396	5	do	Own use at mill in Benwood.
	Benwood	Schad & De Temple	3,800	5	Semi-bituminous	Factories and residents of Benwood.
	Moundsville	Lewis S. Newman	1,140	4	do	Moundsville and vicinity.
	do	Harry W. Brooks	2,660	4	do	Moundsville and State penitentiary.
	MASON COUNTY.					
Hartford City Coal and Salt Co.'s mine.	Hartford City	G. W. Mordock	24,291	4½	Bituminous	Home sales for mf'g salt and retail.
Camden mine	Camden	Consolidated C. and Min Co.	19,400	4	do	Cin., Maysville, Ky., Augusta, Vanceburg, Ky., and Aberdeen, Ohio.
Clifton mine	Clifton	O. and W. Va. Min. and Mf'g Co.	9,492	4½	do	Home and Cin., and other towns on Ohio river below mine.
Sterling mine	do	Sterling C. Co	37,565	4½	Semi-bituminous	Towns along Ohio river.
	MINERAL COUNTY.					
Davis mine, Big seam	Near Piedmont	H. G. Davis & Bro.	61,376	14	Semi-bituminous, blacksmithing.	Balt., Chi., St. Louis, and other points westward.
	Near Burlington	John S. Pierce	880	9	do	Romney.
	Piedmont	Charles P. Dawson	475	6	do	Piedmont.
	MONONGAHELA COUNTY.					
	Morgantown	Chadwick & Meeks	1,400	6	Bituminous	Morgantown.
	do	William Utt	977	6	do	Do.
	do	John Robinson	833	6	do	Do.
	do	Thomas W. Anderson	7,074	6	do	Do.
	Andy	Alex. W. Brown	700	4	do	Andy.
	Laurel Point	Henry Bros	875	10	do	Laurel Point.
	do	Thomas Kyler	700	10	do	Do.
	OHIO COUNTY.					
	Manchester	R. L. Kimberly	20,713	5	Bituminous	Wheeling.
	do	Joseph Werner	6,000	5	do	Do.
	do	McGrinley & McCormick.	5,000	5	do	Do.
	Wheeling	Belmont Nail Co	26,445	5	do	Wheeling (iron-works).
	do	J. L. Hobbs	3,573	5½	do	Wheeling (glass-works).
Riverside Iron Works mine	do	Riverside Iron Works	24,475	5	do	Riverside Iron Works.
Crescent and Richietown mine	do	Casley & Brooks	45,000	5	do	Local trade.
	do	La Belle Iron Works	17,005	5½	do	La Belle Iron Works.
	Fulton	Walter Marshall	7,135	7	Semi-bituminous	Wheeling.
	South Wheeling	M. W. Bell	3,000	5	do	Do.
	Wheeling	Central Glass Co	12,000	5	do	Glass works of company.

Directory of bituminous coal mines—Continued.

WEST VIRGINIA—Continued.

Name of mine and seam.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Thickness of seam.	Kind, and use when reported.	Markets and routes.
	OHIO CO.—cont'd.			*Feet.*		
	Wheeling	Wheeling Iron and Nail Co.	22,425	5	do	Company's iron and steel works.
	Triadelphia	John Stratton	1,800	5	do	Triadelphia and vicinity.
	Elm Grove	W. T. Chambers & Co.	10,469	5	do	Wheeling and B. and O. R. R.
	PLEASANT COUNTY.					
	Bull Creek	William M. Caldwell	3,800	2	Semi-bituminous	Coal-oil works.
	PRESTON COUNTY.					
Irondale mine	Irondale	Felix Nemegyer	22,400	4	Bituminous, coke, fuel, and machinery.	Own furnace and operators.
Austen mine	Austen	C. S. Hurd	27,776	5	Semi-bituminous, coke and domestic.	Ironton furnace, Taylor Co., and local points on B. and O. R. R.
Newburg Orrel mine		Newburg Orrel C. Co	68,383	8	Bituminous, gas	Balt. and B. and O. R. R. Co.
Waldorf mine	Austin	C. S. Hurd	18,000		Bituminous	
	PUTNAM COUNTY.					
Raymond mine, 6-foot seam.	Raymond city	Mannet & Co	49,000	6	Bituminous, semi-cannel	Cin., Louisville, Ind., Frankfort, and Lexington, via R. R. and Kana. and Ohio rivers.
	RANDOLPH COUNTY.					
	Beverly	Stephen B. Hart	525	7	Semi-bituminous	Beverly.
	Roaring creek	Pittston C. Co	805	7	do	Beverly, etc.
	RITCHIE COUNTY.					
	Petroleum	David Pugh	2,625	3	Semi-bituminous	Petroleum.
	TAYLOR COUNTY.					
Montauk Gas C. Co.'s mine, 9-foot seam.	Flemington	Montauk Gas C. Co	68,705	8	Bituminous, gas	New York.
Tyrconnell mine, Pittsburgh seam.	Tyrconnell	Newburg Orrel C. Co	32,504	8	do	Balt. and points on the B. and O. R. R.
		Chris. Robinson	1,050	7	Bituminous	Grafton.
		Geo. Elliot	700	7	do	Prunty town.
	WETZEL COUNTY.					
	Porter's fall	Gustavus L. Wright	380	2	Semi-bituminous	Porter's fall and vicinity.
	New Martinsville	Patrick Magee	380	2	do	New Martinsville.
	WOOD COUNTY.					
	Volcano	Volcano Oil Co	10,944	5	Semi-bituminous	Volcano.
	do	Michael Bean	4,750	5	do	Do.

WYOMING TERRITORY.

	CARBON COUNTY.					
Carbon mine		Union Pacific R'y Co	95,954	6½	Lignite, non-coking	Omaha.
	CROOK COUNTY.					
Philadelphia C. Co.'s mine	21 miles NW. of Spearfish, D. T.	Philadelphia Coal Co	None.	3½-4	Bituminous, lignite	Deadwood, Dak.
Hay Creek mine	do	Blossburg Coal Co	22	8	do	Do.
	SWEETWATER COUNTY.					
Rock Spring mine		Union Pacific R. R. Co.	249,642	2-12	Lignite, non-coking	
	UINTAH COUNTY.					
Rocky Mt. C. and I. Co. mine	3 miles N. of Evanston	Rocky Mt. C. and I. Co	73,554	26	Semi-bituminous, non-coking	C. P. R. R., Virginia City, and domestic use in R. R., and towns in Nevada.
Almy mine	4½ miles N. of Evanston	Coal Dep. Union Div. U. P. R. R.	73,554	26	do	U. P. R. R. locomotives, and domestic use in St. Louis city and other towns.
Almy mine		Union Pacific R. R. Co.	96,869	4-26	do	
Collett mine	Cokeville		No returns.	10-15		
Smith mine	25 m's S. of Twin creek		None.	10-12		
Mammoth mine	Between Harris' fork and Bridger's creek.		None.	55-65		
Bell mine	Head of Twin creek		No returns.	60		

Directory of iron-ore mines.

ALABAMA.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BIBB COUNTY.					
Iron View	Green Pond	J. H. Sharp	5,670	Limonite	Nos. 1 and 2 foundery	South Pittsburgh.
	CALHOUN COUNTY.					
Tecumseh	Jacksonville	Tecumseh Iron Co	1,100	Limonite		Ridge Valley furnace, Ga.
Woodstock	Anniston	Woodstock Iron Co	23,378	do	Car-wheel, pig, and spiegeleisen.	All smelted by Woodstock Iron Co.
		Snow & Clardy	2,180	do		
		John Gordon	141	do		
		Charles Martin	31	do		
		Patrick Fahey	800	do		
		E. B. Nelson	216	do		
	CHEROKEE COUNTY.					
Tecumseh	Tecumseh	Tecumseh Iron Co	20,000	Limonite	Castings, wrought iron, and all kinds of steel, except Bessemer.	
Round Mountain Iron Works.	Round mountain	Round Mountain Iron Works.	1,089	Fossil	Car-wheels, ordnance, chilled rolls, and heavy machinery.	
Stonewall	Stonewall	Miller & Robinson	7,371	Limonite	Ordinary mill and foundery.	All consumed at furnace.
Rock Run furnace	Pleasant Gap	Gray & Bass	4,536	do	Car-wheels	
	DE KALB COUNTY.					
Portersville	Portersville	Rogers & Killian	227	Fossil	Ordinary mill and foundery.	Chattanooga Iron Co., Rising Fawn, Ga., via Ala. Great Southern R. R.
	ETOWAH COUNTY.					
Atalla	Atalla	O. Christopher	11,340	Fossil	Mixing	
Do	do	S. M. Winchester	9,604	do		All piled at railroad.
	JEFFERSON COUNTY.					
New Castle Coal and Iron Co.	New Castle	New Castle Coal and Iron Co.	4,082	Blackband		
Eureka	Oxmoor	Jackson & De Barleber.	40,213	Fossil	Ordinary mill and foundery.	All worked by Eureka furnace.
Alabama Mining and Manufacturing Co.	Warrior	Ernest & Rupp	1,680	Blackband, with coal.		Oxmoor furnace.
	SAINT CLAIR COUNTY.					
Saint Clair	Near Springfield	Hugh Carlisle	12,685	Fossil		Southern States Coal, Iron and Land Co., and Rising Fawn furnace, Rising Fawn, Ga.
	SHELBY COUNTY.					
Shelby	Shelby Iron Works	Shelby Iron Co	25,767	Limonite	Car-wheel pig	Small amount to Central Iron Works, Galena.
	TALLADEGA COUNTY.					
Ore lands of Alabama furnace.	Alabama furnace	Alabama Iron Co	1,140	Limonite	Car-wheels	All used in furnace.
		J. A. Curry	79	do		
		M. S. Curry	9	do		
		David Johnson	617	do		
		Meril Street	111	do		
		Caldwell & Portlow	2,420	do		
		Henry Snow	668	do		
		John H. Riggs	294	do		
	TUSCALOOSA COUNTY.					
Standiford	Green Pond	Blalock Hickman & Salmonds.	14,152	do	Com. mill and foundery	All to Eureka furnace, Oxmoor, via Ala. Gt. Southern R. R. & Nth. & Sth. R. R.

COLORADO.

	LAKE COUNTY.					
Breece		Breece Mining Co	8,482	Specular	Flux	Various smelting establishments about Leadville.

Directory of iron-ore mines—Continued.

CONNECTICUT.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	LITCHFIELD COUNTY.					
Chatfield	Salisbury	Chatfield Mining Co	11,200	Limonite	Cast car-wheels	Home market, Sharon Valley I. Co., Hunts Lyman I. Co., Barnum, Richardson Co., Cornwall, Bridge Co., Millerton I. Co., Lime Rock.
Salisbury Old Hill	Ore Hill	Brookpit Mining Co	14,405	do	Car-wheels and malleable castings.	Barnum, Richardson Co., North Canaan, Hunts Lyman, So. Canaan, Kent. I. Co., Kent, Cornwall, Bridge I. Co., Lime Rock, Sharon Val. I. Co., Irondale, Millerton & N. East.
Davis ore-bed	Salisbury	Davis Digging Co	9,272	do	do	Furnace of Barnum, Richardson & Co., Hunt & Lyman Iron Co., Huntsville, Conn., Lime Rock Iron Co., Lime Rock, Conn.
Kent ore-bed	Near Kent		None.	do		
Roxbury or Shepaug	Roxbury		None.	Spathic		
Chapin	Two miles west of Chapinvile.	J. and N. C. Scoville	140	Limonite		

DELAWARE.

	NEW CASTLE COUNTY.					
E. Chestnut Hill	Newark	Thos. B. McConaughey	2,054	Limonite	Gray forge and boiler iron.	Schuylkill and Philadelphia.
Chestnut Hill	do	Wm. McConanghey	672	do	do	Schuylkill.

GEORGIA.

	BARTOW COUNTY.					
Roane I. Co.'s			None.	Specular		
Munford's I. ore-bank.			3,000	Limonite		
Bartow I. Ore Bank	Bartow Iron Works.	Bartow Fce. Co	3,584	do	Mill iron	Own furnace.
Munford	Four miles from Rogers station.	Munford	3,920	do	Foundery and rail	Rogers furnace, W. & A. R. R., Atlanta Rolling-Mill, Vulcan I. & Nail Wks., Chatt., Tenn.; Lookout Rolling-Mill, Chatt., Tenn.; Knoxville I. Wks., Knoxville, Tenn., & Bartow I. Wks.
Roane I. Co.'s	Bartow station		None.	Specular		Chattanooga.
Diamond	Cartersville		119	Limonite		
Rogers			None.	do		
	Cartersville		680	do		
		Mark A. Cooper	50	do		
	DADE COUNTY.					
Rising Fawn	Rising Fawn	James C. Warner & Co.	44,225	Fossil	Stores, machinery, bar-iron, and nails.	
		D. Little	517	do		
		D. W. J. Taylor	493	do		
		P. A. Cooper	369	do		
		B. & G. Meeler	493	do		
		C. E. Lynch	369	do		
		A. H. Smith	493	do		
		C. M. Tatum	246	do		
	POLK COUNTY.					
Cherokee Iron Co	Cedartown	Cherokee I. and R. R. Co.	11,620	Limonite	Foundery and mill	All used in company's furnace.
Etna ore-banks	Prior's station	C. M. Pennington	6,237	do	Car-wheels	Used in furnace.
		Vandev nter & McAllister.	15,000	do		

INDIANA.

	MARTIN COUNTY.					
		Tomlinson	351	Limonite		
		Harvey Neighbors	136	do		
		John James	11	do		
		D. Collins	14	do		

Directory of iron-ore mines—Continued.

KENTUCKY.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BATH COUNTY.					
		Bath furnace	550	Limonite		
	BOYD COUNTY.					
		D. D. Geiger	634	Carbonate		
		F. G. Gallup	440	do		
		Ashland furnace	1,390	do		
		Joseph Johnson	327	do		
		Isaac Johnson	150	do		
		John Paul Jones & Co.	344	do		
		George Wurts	300	do		
	CARTER COUNTY.					
Star furnace	Star furnace	Norton Iron Works Co.	2,495	Carbonate	All kinds of merchant iron.	Used in own furnace, Ashland, Boyd county.
		S. S. Dugan	1,500	do		
		H. W. Bates	1,000	do		
		Numerous small openings.	1,700	do		
		do	8,054	do		
	ESTILL COUNTY.					
		Estill furnace	1,500	Carbonate		
	GREENUP COUNTY.					
Hunnewell	Hunnewell	Eastern Ky. R. R. Co	2,381	Carbonate	Foundery Nos. 1 and 2 and mill.	
Penna furnace	Penna furnace	do	4,536	do	do	
		J. L. Worthington	141	do		
	LYON COUNTY.					
Centre furnace	Centre furnace	J. H. Hilman	8,505	Limonite	Car-wheels and boiler-plate.	Cincinnati, St. Louis, Louisville, Pittsburgh, Evansville, and Tenn. Rolling-Works.
	POWELL COUNTY.					
		Estill furnace	1,500	Carbonate		
	TRIGG COUNTY.					
Trigg furnace	Trigg furnace	D. Hilman & Sons	None.	Limonite	Boiler-plate, malleable castings, car-wheels, and fine castings of all kinds.	
Centre furnace	Centre furnace	J. H. Hilman	8,605	do	Car-wheels and boiler-plate.	
		Sylvester Copley	49	Carbonate		
		George Kidd	13	do		
		Barber & Fowler	9	do		
		Chris. Tompast	28	do		
		William Guard	110	do		
		Fred. Diderich	11	do		
		Hiram Payne	17	do		
		L. Guller	3	do		
		Elisha Williams	13	do		
		Samuel Callihan	33	do		
		William Deal	2	do		
		Adrian Millior	247	do		
		Alixis Henshaw	11	do		
		J. L. Price	226	do		
		R. M. Knight	74	do		
		Jasper Stanly	786	do		
		J. M. Berry	6	do		
		Elias McCoy	2	do		
		B. F. Willis	7	do		
		Jere Triplett	105	do		
		Lewis & Barber	54	do		
		Joseph Brown	501	do		
		Chris, Konns	285	do		
		John Jordan	249	do		
		Fred Fossin	68	do		
		J. W. Darby	251	do		
		Green Reve	132	do		
		R. F. Dingess	24	do		
		John Tanner	4	do		
		Elias Henshaw	7	do		
		John Dingess	30	do		

Directory of iron-ore mines—Continued.

KENTUCKY—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	TRIGG COUNTY—continued.					
		D. C. Callihan	19	Carbonate		
		George Donta	9	do		
		Cam. Brown	468	do		
		James Prier	454	do		
		Mat. Tufts	128	do		
		Abe. Jackson	127	do		
		Dave Roberson	197	do		
		Chas. Tazeman	13	do		
		W. and M. Gevhart	486	do		
		Asa Tanner	36	do		
		Elias Kittles	95	do		
		Rans. Williams	405	do		
		Joseph Boggs	8	do		
		C. Myres	14	do		
		Pat. Leary	888	do		
		Bud. Henshaw	635	do		
		George Collins	17	do		
		Chas. Tanner	30	do		
		George Myres	93	do		
		August Wolta	37	do		
		Monroe Stanley	118	do		
		Frank McKenzie & Bro.	19	do		
		Wm. Campbell	100	do		
		Thomas Johns	14	do		
		John Darley	19	do		
		Tim. Evans	19	do		
		Sam. Rice	48	do		
		Harden Riggs	32	do		
		Marion Bucky	223	do		
		Fred. Simpson	27	do		
		Wm. Snoddy	19	do		
		Dave and Jack McFarm.	77	do		
		Man. Gevhart	7	do		
		Joe. Kimbler	63	do		
		Fred. Myres	189	do		
		Jno. Callihan	2	do		
		Joseph Jeffres	29	do		
		Peter Molsbarger	38	do		
		Ge rge Neici	55	do		
		Jno. Lewis	99	do		
		Chas. Croft	150	do		
		Sam'l Patterson	5	do		
		Joseph Coffer	8	do		
		Wm. Molsburger	17	do		
		Harrison Tultz	113	do		
		Company Teams	868	do		
		Henry Straight	1	do		
		Wm. May	95	do		
		Chis. Slim	44	do		
		Wm. Konns	151	do		
		Fred. Donta	304	do		
		R. Brown	422	do		
		L. S. Tufts	155	do		
		Chas. Springer	73	do		
		F. M. Glidden	145	do		
		Farmers' Nat'l Bank	211	do		
			280	do		

MAINE.

	PISCATAQUIS COUNTY.					
Katahdin	Katahdin I. Works	Katahdin I. Co.	6,000	Limonite	Car-wheels, chilled plows, malleable castings, Bessemer and Siemens for sheet.	

Directory of iron-ore mines—Continued.

MARYLAND.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	ANNE ARUNDEL COUNTY.					
	Jessup's	Dr. A. S. Linthicum	2,472	Carbonate		
		Barker & Phelps	62	do		
		C. Bauer	10	do		
		J. H. Bruff	12	do		
		C. Butler	10	do		
		Mrs. Ella Cockey	10	do		
		Mrs. Peter F. Cockey	5	do		
		Creidler & Spears	38	do		
		Allan Dorsey	16	do		
		William H. Dorsey	45	do		
		E. A. Erp	10	do		
		J. Fisher	13	do		
		B. Green	12	do		
		M. Green	11	do		
		Samuel Hallin	15	do		
		R. Jeffrey	10	do		
		P. O. Malloy	44	do		
		R. B Mason	187	do		
		C. Millbrook	120	do		
		P. Mitchell	174	do		
		Shipley & Fairbanks	10	do		
		C. Warfield	14	do		
		James Kyne	368	do		
		Jno. S. Tyson	319	do		
		Henry Myers	3	do		
		Josh. Anderson	69	do		
		William Phelps	104	do		
		George K. Bowers	31	do		
		W. H. Brooks	20	do		
		W. L. Gardner	150	do		
		John Gross	38	do		
		Thomas I. King	256	do		
		Paul R. Lamp & Co	99	do		
		Stephen Lingohr	52	do		
		Fred. Sliver	141	do		
		Hog Powell	4	do		
		Thomas Scully	90	do		
		Richard Smeardon	13	do		
		B. Brooks	33	do		
		W. Butler	26	do		
		William Englehart	11	do		
		—— Henderson	8	do		
		William Makely	4	do		
		Michael Scully	15	do		
		John I. Plummer	10	do		
		—— Welsh	13	do		
		Willis Corbin	15	do		
		Thomas H. Hood	74	do		
		Samuel Jeffreys	22	do		
		John Latchford	31	do		
		Joshua Owens	47	do		
		John Snorter	11	do		
		William Stockett	86	do		
		E. H. Shipley	182	do		
		Murty Kyne	554	do		
	ALLEGHANY COUNTY.					
Bowery	Bowery furnace	C. C. & I. Co	3,253	Limonite	Wrought and cast iron	
		Bowery furnace	1,005	Fossil		
		C. M. McCulloh	240	Limonite		
		James Cane	13	Fossil		
	BALTIMORE COUNTY.					
Wood	Timonium	Ashland Iron Co	560	Limonite	1, 2, and 3 foundery	Ashland.
Green Spring	Green Spring	do	4,032	do	do	Do.
Port Spring	Port Spring	do	5,040	do	do	Do.

Directory of iron ore mines—Continued.

MARYLAND—Contniued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
Morris	Two miles from Baltimore.	Geo. P. Whitaker & Co.	2,240	Carbonate	Car-wheels and mill-castings.	Operator's Principio furnace.
Oregon	Oregon	Ashland Iron Co	5,600	Limonite	Iron of great strength	All to Ashland.
Kelly	Port Spring	do	4,704	do	1, 2, and 3 foundery	Do.
Worthington	Worthington valley	do	3,360	do	do	Do.
		G. Boyce	2	Carbonate		
		John Briel	11	do		
		T. Briel	5	do		
		Benjamin Brooks	3	do		
		John Brown	2	do		
		Benjamin Brown	3	do		
		John Bryan	3	do		
		J. Bullinger	9	do		
		E. Burke	62	do		
		Mrs. S. J. Burke	135	do		
		David Bury	4	do		
		Frank Bury	108	do		
		R. Burton	3	do		
		George Woods	20	do		
		G. Wagner	11	do		
		Joseph Weeks	6	do		
		F. Wehr	147	do		
		—— Wells	3	do		
		Peter White	10	do		
		George Mills	55	do		
		J. Mason	2	do		
		C. Owen	1	do		
		William Peters	60	do		
		John Pugh	13	do		
		William Pugh	66	do		
		Rever & Brady	510	do		
		Henry Rever	190	do		
		John Riley	3	do		
		George Ruff	43	do		
		John Scott	46	do		
		William Seymour	5	do		
		J. Kaler	8	do		
		Charles King	8	do		
		George King	5	do		
		Conrad Krill	10	do		
		J. Kurtz	11	do		
		Frank Linkham	16	do		
		Robert Linn	[illegible]	do		
		Noble Lorenz	75	do		
		Fred. Martin	10	do		
		Henry Martin	47	do		
		Wm. Martin	24	do		
		J. McDermot	18	do		
		—— McLaughlin	16	do		
		Jno. Hamer	3	do		
		R. Harvey	11	do		
		Halbert Hoffman	1,241	do		
		Sam'l A. Holland	133	do		
		Wm. Holson	64	do		
		J. Horney	31	do		
		Chas. Howard	7	do		
		Geo. Howard	177	do		
		Jno. Hummel	13	do		
		W. Hutson	1	do		
		J. Isaacs	10	do		
		Henry Johnson	4	do		
		—— Joynes	2	do		
		Wm. Fairbanks	122	do		
		—— Eiford	2	do		
		H. Englehart	13	do		
		Jno. Fisher	202	do		
		H. Fiske	11	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		Jacob Frank	21	Carbonate		
		Wm. Geiser	18	do		
		Thomas Grace	1	do		
		Jere Webb	16	do		
		John Webb	2	do		
		John Wiley	28	do		
		George Williams	6	do		
		Jacob Wisner	1,478	do		
		Samuel Woods	44	do		
		J. Spiegle	94	do		
		George Shriver	28	do		
		Henry Shriver	22	do		
		S. Shriver	50	do		
		Samuel Sneed	16	do		
		A. W. Shanklin	92	do		
		Benjamin Snowden	3	do		
		William S. Stewart	3	do		
		David Stier	6	do		
		J. Summerfield	29	do		
		Alex. Thornton	6	do		
		H. Tieman	42	do		
		William Swan	19	do		
		William Gettmann	2	do		
		D. Gregory	2	do		
		Conrad Grill	7	do		
		J. S. Hayes	1	do		
		William F. Hughs	98	do		
		Henry Ackers	100	do		
		James Asher	22	do		
		Jno. Johnson	10	do		
		—— Kahler	9	do		
		Simon Kern	260	do		
		Jno. Lanning	105	do		
		Reuben Longe	217	do		
		Thomas Lynn	56	do		
		—— Madden	10	do		
		John Martin	45	do		
		R. B. Mason	395	do		
		—— McDermot	3	do		
		David McLaughlin	1	do		
		Henry Myers	158	do		
		Chris. Millbrook	30	do		
		—— Miller	31	do		
		Thomas Moore	2	do		
		Louis Motz	81	do		
		Jno. Müller	7	do		
		George Rannusson	3	do		
		David Ring	107	do		
		—— Ravel	1	do		
		Jno. Q. Adams	1	do		
		A. F. Affelder	46	do		
		Thomas A. Agnew	29	do		
		Conrad Aubel	12	do		
		Henry Bach	19	do		
		H. Bacher	2	do		
		Frank Zuicorn	133	do		
		Philip Zink	8	do		
		—— Bentley	1	do		
		—— Button	2	do		
		P. Curry	1	do		
		—— Gorsuch	22	do		
		—— Pitsinger	12	do		
		—— Rathimell	8	do		
		—— Villet	1	do		
		—— Wagner	1	do		
		—— Weinrich	3	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		Frank Corns	1	Carbonate		
		Sam'l Diggs	32	do		
		James Dougherty	1	do		
		Lewis Eck	5	do		
		Geo. Ehrman	9	do		
		Chas. Evans	7	do		
		Geo. Frank	7	do		
		Henry Gabel	104	do		
		Geo. Hammer	1	do		
		—— Hall	14	do		
		Geo. Hammerbacher	96	do		
		Haugh & Lyons	18	do		
		Frank Haynes	17	do		
		Geo. Hummel	4	do		
		Fred. Holson	2	do		
		Conrad Abor	14	do		
		C. Baker	11	do		
		Theodore Baker	15	do		
		M. Ballet	11	do		
		F. Banger	4	do		
		M. Beerman	10	do		
		Joseph Bennett	29	do		
		Thomas Bennett	36	do		
		A. Fock	2	do		
		F. W. Brady	209	do		
		J. Brown	11	do		
		Chas. Buerhaus	156	do		
		Jno. Burns	66	do		
		F. Boblock	1	do		
		Edward Williams	29	do		
		S. Willis	6	do		
		E. W. Wooden	1	do		
		Wm. Wright	42	do		
		Frank Trincow	21	do		
		Conrad Zink	28	do		
		Henry Smith	2	do		
		Richard Smith	24	do		
		H. Jasper	18	do		
		James Taylor	8	do		
		W. Taylor	3	do		
		H. Thomas	12	do		
		Fred. Ditzel	19	do		
		James Downey	127	do		
		Wm. Downey	8	do		
		H. Dunkins	35	do		
		Jacob F. Ebaugh	8	do		
		Jno Eschelman	3	do		
		Geo. Eisel	87	do		
		J. Edods	1	do		
		Wm. Effoede	9	do		
		Geo. Ellenberger	46	do		
		Geo. O. Ely	8	do		
		Henry Elrich	2	do		
		Mrs. M. R. Ewing	375	do		
		Wm. H Butler	18	do		
		Owen Carney	256	do		
		Henry Chaney	9	do		
		Joshua Cohen	1	do		
		G. Cohs	20	do		
		—— Coleman	3	do		
		Frank Counters	3	do		
		Wesley B. Coursey	722	do		
		Robt. Creighton	8	do		
		Chas. Crowner	29	do		
		D. Deboy	9	do		
		E. Dilworth	17	do		
		R. Dilworth	109	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		John Madio	7	Carbonate		
		Jacob Mast	78	do		
		J. M. Matthews	8	do		
		Chris. Maywald	12	do		
		William F. McKenney	41	do		
		Richard Menser	10	do		
		William McMahony	10	do		
		David Miller	1	do		
		E. Miller	147	do		
		J. H. Miller	88	do		
		John Mitchell	1	do		
		Edward Montgomery	25	do		
		Robert Morgan	21	do		
		Thomas Murray	2	do		
		Tornes Mercer	8	do		
		Ludwig Nagle	131	do		
		J. H. Nagle	2	do		
		George Nairey	130	do		
		C. Newton	15	do		
		Jacob Odensoss	695	do		
		John Odensoss	91	do		
		John H. Ogle	100	do		
		J. Orich	15	do		
		George Ochs	11	do		
		C. P. Paine	237	do		
		W. H. Patterson	11	do		
		William Platter	18	do		
		Gottleib Kühner	18	do		
		H. Hoffman	2	do		
		William Hubbert	1	do		
		William Hipple	175	do		
		Andrew Jackson	79	do		
		J. Jackson	1	do		
		Richard Johnson	3	do		
		Samuel Johnson	2	do		
		William Johnson	1	do		
		John Jukes	5	do		
		Elias T. Jenkins	14	do		
		John Kalb	37	do		
		William Kalb	16	do		
		Henry Kellenberg	3	do		
		Pegin Lerawad	1	do		
		Simon Seigel	3	do		
		William Limburg	2	do		
		S. Lingohr	391	do		
		Conrad Lochman	206	do		
		Michael Logan	89	do		
		Fred. Link	38	do		
		Henry Link	20	do		
		Moses Lewis	11	do		
		George Lewis	15	do		
		Lewis Lohn	3	do		
		——— Leckemann	3	do		
		Howard Bowie	2	do		
		Edward Hall	6	do		
		T. B. Hall	46	do		
		Jno. Hallman	17	do		
		——— Hafner	4	do		
		Wm. Hamman	123	do		
		Henry Hausman	169	do		
		Jno. Harrold	10	do		
		Wm. Harris	29	do		
		August Herkenberg	19	do		
		Wm. Hayward	12	do		
		Jno. Helwig	10	do		
		Conrad Helwig	338	do		
		Chas. Hammerbacher	34	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued..

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		Robt. Gable	39	Carbonate		
		W. H. Gable	36	do		
		Geo. P. Gamble	71	do		
		Edward Garrigan	121	do		
		Michael Gegan	317	do		
		Chas. Gegner	67	do		
		Chas. Gibson	4	do		
		Paul Geigner	1	do		
		Sam'l Griffin	34	do		
		Wm. Ham	3	do		
		Jno. Hamlin	5	do		
		Chas. Haberkom	94	do		
		Fred. Haberkom	319	do		
		John Farmer	5	do		
		Obadiah Farmer	56	do		
		John M. Finch	3	do		
		C. Flock	327	do		
		George Fouch	66	do		
		John Fouch	27	do		
		Leonard Forrest	5	do		
		Henry Frederick	3	do		
		Joseph Frederick	25	do		
		E. Freeman	2	do		
		—— Freeburg	3	do		
		Charles H. Gable	147	do		
		Joseph Gable	1	do		
		A. Koppeman	6	do		
		John Kelly	23	do		
		R. Kelly	52	do		
		G. Kessner	1	do		
		C. Kalnie	32	do		
		Henry King	3	do		
		Jacob Kramer	9	do		
		A. Kramer	1	do		
		John Kramer	99	do		
		Robert Kramer	2	do		
		Thomas Kramer	4	do		
		John Kromer	84	do		
		Edward Ross	13	do		
		G. Roth	4	do		
		J. Roth	5	do		
		E. Rogan	3	do		
		George Rogan	9	do		
		H. Rogan	1	do		
		Lawrence Rogan	26	do		
		B. Sandman	26	do		
		Benj. Sawyer	5	do		
		Charles Schabedolf	18	do		
		R. Plummer	2	do		
		George Pumphrey	47	do		
		James Pumphrey	35	do		
		Wm. Queen	22	do		
		Elias Queen	21	do		
		Joseph Queen	6	do		
		Chas. T. Randle	43	do		
		Geo. Randle	16	do		
		R. C. Randle	21	do		
		Wm. T. Randle	367	do		
		—— Reinhardt	4	do		
		—— Ricketts	1	do		
		James Riley	3	do		
		Simon Woods	24	do		
		Chas. Wroten	5	do		
		Jno. Weender	206	do		
		Moses Young	4	do		
		Calas Heish	6	do		
		Fred. Hilts	19	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		A. Higdon	1	Carbonate		
		E. Higdon	1	do		
		Robert Higdon	18	do		
		N. H. Higdon	4	do		
		Zenoka Higdon	10	do		
		Philip Heims	16	do		
		William Heims	4	do		
		J. Hoerr	7	do		
		Robert Hopkins	1	do		
		Henry Hink	280	do		
		G. W. Hoffman	131	do		
		Samuel Allen	3	do		
		S. Allseet	7	do		
		Thomas Allseet	5	do		
		Joseph Anderson	49	do		
		John Baker	1	do		
		L. H. Barnett	17	do		
		Henry Bell	46	do		
		Silas Bell	2	do		
		Adam Bender	294	do		
		B. F. Berry	6	do		
		Charles Biden	251	do		
		L. Blagburn	13	do		
		Geo. M. Ballet	11	do		
		Chas. Bartles	24	do		
		S. Bryant	147	do		
		James Canoles	294	do		
		Wm. Canoles	31	do		
		Thos. Carnes	43	do		
		Thos. Chisholm	30	do		
		Ben. Cook	1	do		
		Peter Cook	27	do		
		Frank Dennis	75	do		
		Daniel Diegel	1	do		
		Jno. Richardson	5	do		
		Joseph Rittenburg	65	do		
		Joshua Scott	18	do		
		August Simon	1	do		
		Josiah Skillman	9	do		
		Mrs. Henry Smith	453	do		
		Bart. Tremper	92	do		
		Joseph Tremper	57	do		
		J. Ulrich	8	do		
		Ernest Weikert	69	do		
		Jno. Winkler	9	do		
		Geo. B. Wartz	2	do		
		Silas Yellowby	7	do		
		N. Ziegler	21	do		
		Frank Zinkham	4	do		
		Patrick O'Brien	1,374	do		
		Joshua Owens	13	do		
		T. J. Richardson	55	do		
		Rittlehouse & Schwartz	6	do		
		Christian Schwartz	15	do		
		George N. Walker	13	do		
		Peter Garrigan	101	do		
		M. Affelder	84	do		
		T. Agnew & Co	286	do		
		John Bowen	4	do		
		Geo. M. Buckingham	10	do		
		D. J. Cook	8	do		
		Richard Daily	10	do		
		August Deering	71	do		
		John Dixon	5	do		
		John Jackson	17	do		
		John Kemp	23	do		
		August Krich	85	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		John Cassidy	4	Carbonate		
		James L. Crafton	17	do		
		J. Deboy	4	do		
		E. Hartke	25	do		
		John Ireland	19	do		
		L. Queen	3	do		
		James D. Reckitt	7	do		
		Y. P. Shultipey	6	do		
		Thomas Grau	2	do		
		Edward Greely	159	do		
		Mrs. Sophia Grill	28	do		
		William Guy	1	do		
		Peter Hagan	80	do		
		H. Hamer	3	do		
		William Furgenstein	2	do		
		William Button	2	do		
		A. Copples	33	do		
		Michael Carr	71	do		
		Patrick Carr	181	do		
		Peter Carr	26	do		
		John W. Clantice	12	do		
		William Cole	122	do		
		—— Conway	19	do		
		Joseph Craig	4	do		
		John Diggs	1	do		
		Daniel Donnelly	24	do		
		John Downs	6	do		
		T. Cornes	24	do		
		J. Thurman	2	do		
		Alexander Tyler	8	do		
		John W. Wade	128	do		
		W. H. Wade	564	do		
		August Watts	29	do		
		George Watts	19	do		
		Thomas W. Jenkins	122	do		
		Frank Koster	135	do		
		Latham & Little	4	do		
		John Leonard	74	do		
		Henry Levi	68	do		
		John Magsamen	81	do		
		Charles Mason	64	do		
		John McCormick	109	do		
		James McLaughlin	13	do		
		Michael Fester	1	do		
		Charles Fiska	33	do		
		William Furkenstein	17	do		
		Jonas Gabriel	75	do		
		Jacob Gerst	62	do		
		John Gerst	51	do		
		Peter Gerst	40	do		
		Robert Ray	21	do		
		Fred. Ulrich	7	do		
		M. Ziegler	22	do		
		Miscellaneous	212	do		
		No name	56	do		
		Christian Bury	22	do		
		Mary C. Cook	21	do		
		F. Dentzel	12	do		
		—— Haberkorn	26	do		
		J. B. Hanney	10	do		
		W. T. Jenkins	177	do		
		—— Johnson	6	do		
		S. Krill	32	do		
		F. Krause	11	do		
		James R. Osburn	14	do		
		Charles H. Dinem	7	do		
		R. G. Dumphey	368	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		P. Flynn	12	Carbonate		
		B. J. Galloway	240	do		
		Thomas Griffin	21	do		
		J. T. B. Parlett	45	do		
		E. Rawlins	37	do		
		Dr. Ridgely	6	do		
		John Ridgely	500	do		
		J. Sedicum	10	do		
		W. B. Sweitzer	166	do		
		H. Ulrich	10	do		
		J. J. Watle	12	do		
		W. Watle	11	do		
		H. Baranger	603	do		
		H. Frybecker	603	do		
		R. Novock	603	do		
		George A. Smith	603	do		
		F. Wehr	603	do		
		J. Hammerbacher	603	do		
		R. G. Dumphey	270	do		
		J. B. Hall	11	do		
		A. Harrold	11	do		
		B. Kramer	11	do		
		A. Links	27	do		
		Joshua Mathews	200	do		
		E. McCauly	11	do		
		Fat. O'Neil	270	do		
		Howard Ridgley	130	do		
		Miscellaneous	52	do		
		G. Bauers	1,276	do		
		O. B. Benson	41	do		
		Louis Berman	2	do		
		William Boblitz	26	do		
		—— Brady	6	do		
		Henry Brewis	37	do		
		L. Butler	3	do		
		—— Schichells	1	do		
		Charles Schulthies	3	do		
		Paul Schulthies	32	do		
		Charles Schwartz	688	do		
		John Schwartz	611	do		
		G. M. Seiss	31	do		
		Paul Sentz	4	do		
		Dennis Simnes	114	do		
		Jacob Smith	335	do		
		John Smith	122	do		
		Joseph Smith	176	do		
		William Snyder	3	do		
		—— Soap	1	do		
		James Rittenhouse	331	do		
		John Robinson	11	do		
		William Robinson	3	do		
		Names unknown	97	do		
		William H. Merrett	48	do		
		Wesley Miller	6	do		
		George Mohr	17	do		
		Henry Mohr	11	do		
		John Mohr	51	do		
		John Neiser	55	do		
		Fred. Noble	12	do		
		M. N. Peters	101	do		
		Prescoe Bros	6	do		
		Samuel Pugh	1	do		
		Thomas Pugh	61	do		
		Henry Reishert	10	do		
		Henry Hurst	9	do		
		John Hurst	11	do		
		Lewis Hurst	12	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BALTIMORE COUNTY—continued.					
		Valentine Roberts	7	Carbonate		
		James Robinson	24	do		
		John Rosengarten	3	do		
		Isaac Smith	28	do		
		Frank Weikert	11	do		
		John White	2	do		
		John Williams	9	do		
		—— Wirth	7	do		
		—— Wright	7	do		
		A. F. Haberkom	103	do		
		L. Hartigan	7	do		
		William Hedrick	2	do		
		B. Johnson	53	do		
		Thomas Kenney	167	do		
		George H. Merryman	7	do		
		George W. Miller	43	do		
		F. C. Moore	118	do		
		Mrs. C. Welch	598	do		
		B. Wilson	67	do		
		H. C. Wilson	23	do		
		John Adams	6	do		
		John G. Bosley	31	do		
		Jacob Brillhart	13	do		
		John Binton	46	do		
		Frank Corcoran	32	do		
	CARROLL COUNTY.					
Eusor ore-bank	New Windsor	Wrightsville Iron Co.	1,954	Limonite	Neutral forge and foundery.	
Miller's ore-bank	Millers	do	2,078	do	do	
Bachman valley	Ebbvale	Grove Bros.	4,804	do	Foundery and forge pig.	All smelted in our furnaces at Danville, Pa.
		Samuel Erb	47	do		
		Mineral Hill Mining Co.	218	Magnetite		
		Avondale mine	6,603	Limonite		
		Westminster ore-bed	143	do		
		Myers ore-bank	1,356	do		
		Horace L. Brook	132	do		
		James Maxwell	16	do		
	CECIL COUNTY.					
		Principio I. furnace	2,016	do		
	FREDERICK COUNTY.					
Catoctin	Catoctin furnace	J. B. Kunkel	17,843	do	Car-wheels, malleable and machine castings, steam-cylinder, boiler, and armor-plates.	
		Mrs. McPherson	99	do		
		C. S. Hurd	224	do		
	HARFORD COUNTY.					
		John Lynch	191	Carbonate		
		James Stansbury	2	do		
		E. C. Volly	3	do		
		A. P. McCombs	81	Limonite		
	HOWARD COUNTY.					
		W. J. Disney	12	Carbonate		
		P. J. Mitchell	507	do		
		T. H. Talbot	47	do		
		T. H. Brown	1,171	do		
		J. C. Gaylor	122	do		
		A. J. Harmon	58	do		
		William Henson	8	do		
		T. H Hoods	11	do		
		Samuel Jeffreys	79	do		
		William E. Jeffreys	23	do		
		R. B. Mason	162	do		
		P. G. Mitchell	2,729	do		
		Michael Reynolds	3,740	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	HOWARD COUNTY—continued.					
		V. Riemsneider	148	Carbonate		
		Wm. M. Stockett	32	do		
		Thomas Wheeler	8	do		
		W. Mass	10	do		
		Chas. A. McCann	10	do		
		H. Myers	13	do		
		J. Norris	28	do		
		V. Reimsnyder	231	do		
		J. Smith	11	do		
		Geo. W. Dorsey	18	do		
		Benj. Green	109	do		
		Michael Loffy	731	do		
		Jno. McManus	287	do		
		—— Menshaw	13	do		
		William Yeager	104	do		
		William Kyne	50	do		
		H. Russell	48	do		
		George W. Hobbs	2,873	do		
		W. Walker	11	do		
		P. R. Wilson	1,123	do		
		William Caples	7	do		
		C. Williams	7	do		
		Jno. Wesley	16	do		
		E. A. R. Earp	6	do		
		F. Ellster	5	do		
		A. L. Guyton	20	do		
		Joseph Hartke	9	do		
		Owen Kearney	10	do		
		A. S. Linthicum	64	do		
	MONTGOMERY COUNTY.					
		Philip Bird	25	do		
	PRINCE GEORGE COUNTY.					
		C. C. Jacobs	38	do		
		J. B. Ridgeway	28	do		
		G. Simon & Bro	35	do		
		Cæsar Smith	10	do		
		Smith & Friel	145	do		
		Richard Smith	368	do		
		B. Sullivan	8	do		
		Geo. N. Walker	55	do		
		James Watts	30	do		
		Jno. Wells	24	do		
		Geo. Wheeler	5	do		
		James Woods	1,755	do		
		S. Rufus Belt	53	do		
		James O'Brien	827	do		
		Thos. Burfit	97	do		
		R. W. Burgess	224	do		
		James Collins	720	do		
		John Coughlin	12	do		
		Thos. Foster	9	do		
		Chaney Howell	8	do		
		W. F. Howell	26	do		
		W. A. Linthicum	46	do		
		Wm. Alton	10	do		
		R. Anderson	62	do		
		L. Brashears	6	do		
		John Brewer	15	do		
		H. Brock	2	do		
		O. Brown	5	do		
		W. T. Jones	2	do		
		Antoine Lemoine	50	do		
		Chas. Lorentz	29	do		
		Brook Matthews	4	do		
		Moses Matthews	3	do		

Directory of iron-ore mines—Continued.

MARYLAND—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	PRINCE GEORGE COUNTY—cont'd.					
		Buck Merson	35	Carbonate		
		R. McFee	42	do		
		Carl Millbrook	306	do		
		Joseph Miller	46	do		
		Geo. Mitchell	2	do		
		Mark & Clymer	414	do		
		D. O'Brien	19	do		
		A. Robinson	48	do		
		Geo. Donaldson	436	do		
		Peter Dorsey	13	do		
		Mrs. M. Duval	8	do		
		M. Fallow	2	do		
		Patrick Friel	417	do		
		B. Gorsuch	4	do		
		B. Haker	54	do		
		Wm. Hicks	7	do		
		T. Hopkins	15	do		
		Jno. Ingraham	8	do		
		R. T. Jeffries	3	do		
		Notley Johnson	113	do		
		Wm. Shay	216	do		
		Henry Brebaker	14	do		
		Dennis Collins	123	do		
		Mrs. James Collins	29	do		
		Charles Lorenz	25	do		
		Catherine Yockel	15	do		
		George Yokel	699	do		
		Welling & Harrison	55	do		
		James Simnes	130	do		
		John Walker	53	do		
		L. G. Welsh	97	do		
		Halbert Hoffman	1,058	do		
		Hugh Watts	28	do		
		R. W. Burgess	39	do		
		Thomas Carrick	21	do		
		Frank Carter	35	do		
		Joseph Carter	12	do		
		Charles J. Chalk	22	do		
		Dr. Childs	7	do		
		Josh Crawford	2	do		
		John Latchford	892	do		
		Mrs. E. W. Lester	12	do		
		Charles Lorentz	238	do		
		Michael McCann	35	do		
		Welleng & Anderson	23	do		
		George H. Beall	754	do		
		Johanna Burfit	469	do		
		James I. Perkins	112	do		
		John Simms	20	do		
		J. McMullikin	48	do		
		John S. Tyson	26	do		
	WASHINGTON COUNTY.					
		Antietam furnace	560	Limonite		

MASSACHUSETTS.

	BERKSHIRE COUNTY.					
C. Lect ore-bed	West Stockbridge	Hudson Iron Co	19,079	Limonite		Hudson Iron Co., Hudson, N. Y., via B. & A. R. R.
Mason & Bliss	Cheshire	Jagger Iron Co	1,368	do		
Bank	Richmond	John Raser	5,040	do	Foundery, machinery, stove-plate, mowing- and reaping-machines.	Pomroy Iron Co., West Stockbridge, Mass.
Bacon	do	Charles B. North	280	do	do	West Stockbridge.

Directory of iron-ore mines—Continued.

MASSACHUSETTS—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BERKSHIRE COUNTY—continued.					
Gates	Richmond township.		None.	Limonite		
Andrews	do		None.	do		
Hancock Shakers	Pittsfield township		None.	do		
O. B. Goodrich	West Stockbridge	Lawrence Moffatt	2,197	do	Car-wheels	Pomroy I. Works, West Stockbridge, Mass.
O. B. Sherman	Lanesborough	J. L. Colby	5,600	do	do	
Leet	West Stockbridge	Richmond Iron Works	9,211	do	Cannon, car-wheels, and strong machinery.	Furnaces of Richmond Iron Works.
Cone	Richmond	do	7,828	do	do	Own furnace.
Cheever	do	do	12,034	do	do	

MICHIGAN.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BARAGA COUNTY.					
Spurr Mt. I. Min. Co.	Spurr mountain		None.	Magnetite		
	MARQUETTE COUNTY.					
Milwaukee	Negaunee	John Q. Adams and James F. Foley.	3,360	Limonite		Cleveland, Ohio.
Edward	Humboldt	W. W. Wheaton	None.	Magnetite and specular.		Do.
Michigamme	Michigamme	Michigamme Co	66,158	Magnetite		Cleveland, Erie, Ashtabula, and Chicago.
L. Superior I. Co.	Ishpeming	Lake Superior I. Co	215,930	Specular and hematite.	Bessemer steel, pig	Cleveland, Ohio, Chicago, Ill., Detroit, Mich., Buffalo, N. Y., and Erie, Pa.
Kloman	Republic	Shennway, Wicker & Co	None.	Specular		Lake Erie ports.
Howe, "Old Pillsburg", or L. Superior.	Palmer	D. H. Bacon and W. N. Morse.	981	do	Bessemer	Cleveland, Ohio.
Goodrich	Stoneville	A. E. Goodrich	6,720	do	do	Chicago, Ill., and Milwaukee, Wis.
Champion	Champion	Champion Iron Co	99,600	Magnetite and specular.	Bessemer pig	Cleveland, Ashtabula, Erie, and Chicago.
New York	Ishpeming	New York Iron mine	44,971	Specular	Bessemer steel, mill, bar, hoop, sheet iron, nails, etc.	Chicago and lake Erie ports.
Chicago	Negaunee	W. S. Calhoun and J. F. Stevens.	3,304	Limonite	Foundery	Cleveland, Ohio.
Bessemer	do	King & Wheeler	24,640	do	Bessemer	Do.
Mitchell	Tilden	Mitchell Mining Co	17,920	do	do	Do.
Keystone	Champion	Saginaw Mining Co	10,080	Magnetite and specular.	Mill and foundery	Do.
Saginaw	Stoneville	do	30,240	Specular	Bessemer	Do.
National	National	National Iron mine	33,600	do	Bessemer steel	Do.
Barnum	Ishpeming	Iron Cliffs Co	28,000	do	do	Chi. and Cleveland, via C. and N. W. R. R.
Section 12	Negaunee	do	6,720	Limonite		Do.
Republic	Republic	Republic Iron Co	224,000	Specular and magnetite.	Bessemer and mill	Lake Erie ports, by M. H. and O. R. R., and lake.
Winthrop		Winthrop Hem. Co	47,168	Limonite	Pig, especially Bessemer	Pa., Ohio, Ill., Mich., and Minn., via C. and N. W. R. R., M. H. and O. R. R., and lake.
McComber	Negaunee	McComber Iron Co	33,600	do	All kinds	Middle and western states.
Cleveland Iron Mining Co.	Ishpeming	Cleveland I. M. Co	125,440	Specular	do	Do.
Salisbury	do	Iron Cliffs Co	25,000	Limonite	Bessemer steel	Chicago and Cleveland, via C. and N. W. R. R., and water.
Cambria	Negaunee	Cambria Mining Co	6,720	do	do	Chicago, via C. and N. W. R. R., and water.
Pendill	do	Union Mining Co	20,160	do	Car-wheels, malleable and gray castings, agricultural implements, and machinery.	Local.
Gilmore	do	Iron Cliffs Co	None.	Specular		
Excelsior	Ishpeming	do	None.	do		
Foster	Negaunee	do	None.	Limonite		
Humboldt	Humboldt	Humboldt Iron Co	17,321	Magnetite and specular.	Car-wheels and malleable iron.	Cleveland, Ohio.
Cheshire	Cheshire	Cheshire Iron Co	20,582	Hematite	Bessemer steel, red short, foundery, and mill.	Cleveland, Ashtabula, via C. and N. W. R. R., and lake.
Jackson	Negaunee	Jackson Iron Co	134,585	Specular	Bessemer	Sharon, Chicago, and Cleveland, Fayette.
Manganese	do	J. W. Schadt and Chas. Schrottky.	11,240	Limonite		Cleveland and Chicago, via M. H. and O. R. R.
N. Y. Hematite	do	Neil & Sweeny	2,240	do		Via C. and N. W. R. R.
Cleveland Hem	Ishpeming	Robert Nelson	18,730	do	Steel rail	Appleton, Wis., and Chicago.
Palmer or Cascade			33,508	Specular		
Elmore		Neeley & Sweeny	None.			

Directory of iron-ore mines—Continued.

MICHIGAN—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	MARQUETTE COUNTY—continued.					
Rolling-Mill	Negaunee	George Berringer	14,157	Limonite		Cleveland, Ohio, Joliet, Ill., and some local furnaces.
Lake Angeline	Ishpeming	Pittsburgh and Lake Angeline Iron Co.	16,719	Specular	Bessemer steel	Chicago.
	MENOMINEE COUNTY.					
Vulcan	Vulcan	Menominee Mining Co.	83,394	Hematite	Bessemer steel	Milwaukee, Chicago, Cleveland, Pittsburgh, and Johnstown.
Norway and Cyclops	Norway	do	210,875	do	do	Do.
Quinnesec	Quinnesec	do	63,689	do	do	Do.
Lowell and E. Vulcan	Vulcan	do	6,171	do	do	Do.
Chapin		do	7,878	do	do	Do.
Stephenson	Norway	Lumbermen's Min. Co.	14,000	do	Mixing with hard ores and Bessemer steel.	Chicago, Cleveland, and Milwaukee.
Cornell	Quinnesec	Wright & Cornell	7,840	do	Bessemer	Cleveland, Ohio.
Curry Iron Co	Vulcan	John Outhwaite	21,813	do	Bessemer steel and mill	Pittsburgh and Mahoning valley.
Ludington	Iron Mountain city	Lumbermen's Min. Co	2,800	do	Bessemer steel	Chicago, Cleveland, Milwaukee, and Erie, via lake.
Perkins	Norway	Saginaw Mining Co	35,840	do		Cleveland, Ohio.
Brenn	Waucedah	Emmett Mining Co	5,600	do		Cleveland, Ashtabula, and Chicage, via C. and N. W. R. R., and boat.
Emmet	do	do	31,447			

MISSOURI.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	CRAWFORD COUNTY.					
Scotia No. 2	7 ms. S. of Bourbon	Scotia Iron Co	11,200	Hematite and specular.	Bessemer pig	Smelted by Scotia furnace, Scotia.
Taylor	9 miles NW. of Cuba	James & Green	819	do	Bessemer	All to Vulcan Steel Works, St. Louis, Mo.
McGarvey or McDonald.	8 miles SW. of Leasburg.	McGarvey	633	Hematite	Bessemer pig	All to Missouri Iron Co., Saint Louis, Mo.
Iron Ridge No. 2	Iron Ridge	Republic Iron Min. Co	336	Hematite and specular.	do	South Saint Louis.
Zane or Shotwell	2 ms. NE. of Midland	Midland Blast-Furnace Co.	784	do	Bessemer steel	All to Midland Blast-Furnace Co.
Steelville, Seay or Marsh.	1 mile S. of Steelville.	Phillips, Bennett & Thurman.	1,680	Specular	Foundery	Do.
Wilson's Mills	1 mile S. of Wilson's Mills.	J. D. Butt	62	do		
Pinnell	2½ miles NE. of Leasbury.	E. A. Pinnell	506	Hematite	Bessemer pig	All to Saint Vulcan Steel Works.
Meramac I. Min. Co	Cherry Valley	Meramac I. Min. Co	60,385	Specular	Fix. and all kinds of pig.	Carondelet and Midland.
R. R. ore bank	1½ miles NE. of Midland.	M. B. F. Co	1,493	do	Bessemer and foundery	All to M. B. F. Co.
Clark No. 1	Near Midland	N. G. Clark	336	do	Bessemer pig	Do.
Cole	5½ ms. S. of Bourbon.	Wm. James, Isaac Davis, John and James Reves.	734	Hematite and specular.	Bessemer pig and best wrought.	Vulcan Steel Works, St. Louis, also Inda.
Smith or Clark No. 2.	2½ miles W. of Cuba.	N. G. Clark	225	do	Bessemer steel	All to Saint Louis.
Iron Ridge	Iron ridge	Republic I. Min. Co	7,840	do	Bessemer pig	All to So. Saint Louis Vulcan Steel Works.
	DENT COUNTY.					
Orchard	Salem	Salem Iron Co	949	Hematite and specular.	Bessemer pig	Lewis Iron Co., Grand Tower, Ill.
Morns	6 miles E. of Salem	Dent Iron Co	560	do	do	
Jamison	3 miles S. of Salem	Missouri Iron Co	873	do	Mixing for Bessemer pig.	Saint Louis, Mo.
Pomeroy	3 miles NW. of Salem.	Eben James	9,487	do	Bessemer pig, neutral	All to Saint Louis.
Pittsburgh or Preston.	Salem	Missouri Iron Co	644	do	Mixing	Saint Louis, Mo.
Simmon's Mountain	1 mile SW. of Salem.	do	17,608	do	Bessemer pig	Do.
Thomas	4 miles W. of Salem	M. B. F. Co	2,493	do	Foundery	All to M. B. F. Co.
Sligo	2 miles E. of Sligo furnace.	Sligo Furnace Co	460	do		All smelted at Sligo furnace.
Riverside	7 miles SE. of Salem	Riverside Iron Works.	9,859	do	Mixing for mill	Riverside Iron Works, Wheeling, W. Va.
Watkins	12 miles NW. of Salem.	W. J. Sanky	1,676	do	Bessemer pig	All to Saint Louis.
Hawkins	2 miles W. of Avery.	M. B. F. Co	2,201	do	Mixing for Bessemer pig.	All to M. B. F. Co.
Dry Fork	12 miles N. of Salem	S. M. Smith & Co	1,725	do	Bessemer pig and mixing.	All to Saint Louis.
Fitzwater	5 miles S. of Sligo furnace.	Sligo Furnace Co	2,300	do	Fix	Mo. Iron Co., Saint Louis, Mo.
Hitchen's Creek	9 miles E. of Salem	William James	499	do	Bessemer pig and fix	Wabash Iron Co., Terre Haute, Ind., and East Saint Louis, Mo.
Fergason or Milsap	Salem	M. B. F. Co	7,543	do	Bessemer pig	All to M. B. F. Co.

Directory of iron-ore mines—Continued.

MISSOURI—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	FRANKLIN COUNTY.					
Hurst or Halligan	3 miles S. of Dry branch.	Booth, Smith & Co	336	Hematite and specular.	Bessemer steel	Vulcan Iron Works, Saint Louis.
Saint Clair	Saint Clair	Bennett & Buskipp	2,128	do	do	St. Louis, Mo., and Shoals, Ind.
Judith Spring M. Co.	Stanton Copper mines.	Bennett & Thurman	5,600	do	Steel	Do.
	GASCONADE COUNTY.					
Keffer	12 miles north of Cuba.	Phillips, Bennett & Thurman.	1,120	Hematite and specular.		Mo. Furnace Co., Saint Louis, Mo.
	IRON COUNTY.					
Pilot Knob	Pilot Knob	Pilot Knob Iron Co	52,761	Specular	Bessemer pig	Carondelet, Mo., Pittsburgh, Pa., Pilot Knob, Mo., Grand Tower, Ill., Wheeling, W. Va., and Ashland, Ohio, via St. L., I. Mt. and So. R. R. and Miss. and Ohio rivers.
Russel Mountain	3 miles west of Pilot Knob.	Peckham Iron Co	56	do		Kemmswick, Jefferson county.
Shephard Mountain	Pilot Knob	Pilot Knob Iron Co	4,480	do	Bessemer pig	Saint Louis, Mo., Pilot Knob. Iron Co.
	PHELPS COUNTY.					
Dawson	Near Rolla	William James	27	Hematite and specular.	Bessemer steel, pig	Carondelet.
Clinton	12 miles northwest of Salem.	Missouri Iron Co	15,361	Specular	Bessemer pig	Saint Louis.
McDole	Maramec Iron Works	William James	278	Hematite and specular.	Bessemer steel, pig	Carondelet, Mo.
Hyer	Near Rolla	do	585	do	Bessemer pig	Do.
Reed	do	do	1,650	do	do	Do.
Saint James	Saint James	do	279	do	Bessemer pig, boiler, cast-steel, malleable castings, and car-wheels.	Moselle county, Mo., Big Muddy county, Ill., Western Iron Co., Ind., Ozark county, Mo., Gaylord Iron and Pipe Co., Newport, Ky.
Lamb	4 miles north of Avery station.	Saint Louis Iron Mining Co.	2,735	do	Bessemer pig and fix	Carondelet, Mo., and Wheeling, W. Va.
Stimpson	12 miles south of Saint James.	Missouri Furnace Co	5,600	do	Bessemer pig	Missouri Furnace Co., Saint Louis, Mo.
Smith	12 miles southwest of Salem.	Missouri Iron Co	2,811	do	do	All to Saint Louis.
	SAINT FRANÇOIS COUNTY.					
Iron Mountain	Iron Mountain	Iron Mountain Co	144,153	Specular	Bessemer pig, crucible steel, strong tensile, strain bar and plate, car-wheels, malleable castings and mixing.	St. Louis and Upper Ohio river, via I. Mt. R. R. and Ohio river.
Wilson ore bank	2 miles south of Bismarck.	Reuben W. Wilson	112	Limonite	Flux	Saint Joe Lead Co. Mine, La Motte.
	WASHINGTON COUNTY.					
Burnett ore bank	14 miles northwest of Potosi.	Frank Burnett	214	Hematite	Bessemer pig	Carondelet, Mo.

NEW JERSEY.

	BERGEN COUNTY.					
Butler	Near Sufferns	G. W. Suffern and R. F. Galloway.	280	Magnetite		
	HUNTERDON COUNTY.					
Hager	Milford	Holland Mining Co	800	do	Foundery	Coleraine Iron Works, Gainson Furnace, Lyons Station and Redington, Pa., via B. and D. R. R. and Lehigh R. R.
Turkey Hill	West End	West End Iron Co	11,087	do	Bessemer pig	Bethlehem Iron Co., Bethlehem, Allentown Iron Co., Allentown, Carbon Iron and Pipe Co., Parryville, Lucy Furnace Co., South Glendon, Dunbar Furnace Co., Dunbar and Crane Iron Co., Catasauqua, Pa.
Silverthorn	High Bridge	S. K. Large & Co	252	do	Grey forge	Coleraine Iron Co., Redington, Pa.
Large	do	do	112	do	No. 1 foundery	Lehigh Iron Co., Allentown, Pa.
Cregar	do	Andrew Cregar	280	do	Foundery	Allentown, Pa.
Eveland	Glen Gardner	Lewis Barnes	224	do	Rolling-mill	
Pidcock	Near Anderson	T. and S. Pidcock	156	do		Musconetcong Iron Co., Stanhope, N. J., and Carbon Iron Company, Coplay, Pa.
Radley	Lebanon	Lewis Barnes	78	Limonite		
Petty	Near Bloomsbury	David McCrea	45	Magnetite		
Wean	West End	John P. Wean	566	Limonite		All to Easton, Pa.

Directory of iron-ore mines—Continued.

NEW JERSEY—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	HUNTERDON COUNTY—continued.					
Maberry	Glen Gardner	Halsey J. Boardman	336	Magnetite	Bessemer	
Case	Near Pattenburgh	David McCrea	28	do		
Neighbor	Near Califon	Sylvester Neighbor	896	Limonite	Bessemer steel	All to Taylor Iron Works, Chester, N. J.
Union Church	Norton	Cooper & Hewitt	None.	Magnetite		Durham Iron Works.
Swayze	West End	West End Iron Co	None.	do		
Asbury	Asbury	do	54	do	Bessemer	Carbon I. and P. Co. and Crane Iron Co.
Old Furnace	High Bridge	E. P. Merritt and F. H. Smith.	None.	do		
Rodenbaugh	Bethlehem township	West End Iron Co	31	do	Bessemer	Carbon I. and P. Co., Parryville, Pa.
Annandale	Annandale	Lewis Barnes	627	do	Rolling-mill	Keystone furnace, Reading, Pa., and Topton furnace, near Reading, Pa.
Taylor	High Bridge	Llewellyn James	2,114	do	Grey forge	Hokendauqua.
Sharp	do	David Neighbor	None.	do	Ordinary pig	Peter Uhler's furnace, Glendon.
Gray	Whitehall	Saucon Iron Co	1,940	do	Foundery, forge, and Bessemer.	
Turkey Hill	West End		None.			
Burrill	Tewksbury township		None.			
Fisher or Fix Hill	do		None.			
Wild Cat	Bethlehem township	Theo. Hoffman	None.			
Wright	do		None.			
Mattison	Lebanon township		None.			
Nalf	Holland township		None.			
	MORRIS COUNTY.					
Randall Hill	Mine Hill	Crane Iron Co	8,363	do	No. 1 foundery pig	Catasauqua, Pa.
Millen	do	Executor estate of Jas. C. Lord.	1,263	do	Foundery and gray forge.	Port Oram and Boonton, N. J., via D., L. and W. R. R.
Baker	do	Lackawanna Coal and Iron Co.	14,696	do	Bessemer pig and foundery.	Franklin furnace, Franklin, N. J.; Saucon Iron Co., Hellertown; Lehigh Iron Co., Allentown; Bergman & Co., Danville; Bergen Iron Co, Secaucus, and Musconetcong Co., Stanhope.
Hibernia	Hibernia	Glendon Iron Co	85,623	do	Mixing for forge and foundery.	Glendon furnace and Lehigh furnaces, via Hibernia Mine R. R., D., L. and W. R. R. and L. V. R. R.
Green Pond	Near Charlotteburgh	Chas. E. Maxwell	18,053	do	All kinds of pig except cold short.	N. J. and Pa., via C. and G. P. R. R., and Midland R. R.
Hacklebarney	Chester	Chester Iron Co	31,182	do	Rolling-mill	Aitkin Bros., Pottsville; Crane Iron Co., Catasauqua; Reading Iron Co., Reading; Pennsylvania Steel Co.; Montgomery Iron Co.; Jas. Hoover & Sons, G. H. Brown, Andover Iron Co., and Cooper & Hewitt.
Black Hills	Near Suckasunny	A. Pardee	2,195	do	Bessemer	Secaucus, N. J., via M. and E. R. R.
King	do	do	2,564	do	Foundery	Furnaces in Lehigh Valley, and some to Musconetcong Iron Works, via D. L. & W. R. R. and C. R. R. of N. J.
Weldon	Jefferson township	Wm. E. Dodge and others.	1,277	do	Forge	Local furnaces and Lehigh Valley.
Hurd	Port Oram	Thomas Iron Co	11,200	do	Foundery pig, bar-iron	High Bridge, C. R. R. of N. J., and S. and T. Div.
Stoutenburgh	Schooley mountain	Jos. Wharton	1,680	do	No. 1 pig and forge	Lehigh Valley, Pa.; Stanhope, Sussex Co., N. J., via M. and E. R. R., and H. B. C. R. R. of N. J.
Samson	Chester	Cooper, Hewitt & Co	3,360	do	Foundery and mill	Lehigh Valley and Durham furnaces, via C. R. R. of N. J., Pa. R. R., and L. V. R. R.
Combs	Ironia	Mrs. Julia A. Canfield	4,480	do	Bessemer pig	Lackawanna Coal and Iron Co., Scranton, Pa., via D., L. and W. R. R.
Cooper	Chester	Cooper Iron Mining Co.	5,867	do	Forge and foundery	Chestnut Hill Iron Co., Musconetcong Iron Co., Pottstown Iron Co., Lehigh Iron Co., and Coplay Iron Co., via D., L. and W. R. R. and L. V. R. R.
Dodge	Jefferson township	Wm. E. Dodge and others.	358	do	Forge	Local furnaces and Lehigh Valley.
Bryant	Suckasunny	John D. Evans	6,720	do	Bessemer	Bethlehem Iron Co., Bethlehem, Pa., via D., L. and W. R. R. and L. V. R. R.
Dickerson	Near Suckasunny	A. Pardee	28,914	do	Foundery pig	Musconetcong Iron Works and Lehigh Valley furnaces, via D., L. and W. R. R. and C. R. R. of N. J.
Lawrence & De Hart	Near Ironia	Reading Iron Co	763	do	do	Reading Iron Works, Reading, Pa., via D., L. and W. R. R., L. V. R. R., and P. and R. R. R.
Sterling	Port Oram	Thomas Iron Co	16,800	do	Foundery pig and bar	H. B. C. R. R. of N. J. and S. and T. division.
Orchard	do	Executor estate of Jas. C. Lord.	14,048	do	Foundery and gray forge	Port Oram furnace, Port Oram; Boonton furnace, Boonton, and Lehigh and Schuylkill Val. furnaces, via D., L. and W. R. R. and various Pennsylvania railroads.
Byram	Mine Hill	Andover Iron Co	16,666	do	No. 1 foundery	Andover furnace, Phillipsburgh, N. J.

Directory of iron-ore mines—Continued.

NEW JERSEY—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	MORRIS CO.—cont'd.					
Mount Olive	Mount Olive	Wm. George & Co	1,625	Magnetite	Mill and wrought-iron pipe.	Reading Iron Works and Lyon furnace, via C. R. R. of N. J., and L. R. R.
Rockaway Valley	Near Powerville	Paul P. Todd	569	do	Forge and foundery	Boonton furnace, Boonton.
Gove	Drakesville	Francis N. Gove	3,920	do	No. 1 foundery	Coleraine furnace, Lehigh Valley, via M. and E. R. R. and L. V. R. R.
Charlotteburgh	Charlotteburgh	Cooper & Hewitt	3,920	do		Pennsylvania and New Jersey, via D., L. and W. R. R.
Davenport	Green Pond					
Beach Glen	Hibernia	Executor of estate of Jas. C. Lord.	9,486	do	Foundery and gray forge	Boonton furnace, Boonton, and Lehigh Valley furnace, via Hibernia R. R., D., L. and W. R. R. and L. V. R. R.
Mount Hope	Mount Hope	Mount Hope Mining Co.	50,379	do		Furnaces in Lehigh valley, via Mount Hope Min'l R. R., D., L. and W. R. R. C. R. R. of N. J., and L. V. R. R.
Richard	Near Dover	Thomas Iron Co	35,464	do	Mixing for foundery and forge.	Thomas Iron Co., Hokendauqua, via M. and E. R. R., L. V. R. R., and Mt. Hope R. R.
Dalrymple	Near Mine Hill	Crane Iron Co	2,651	do	No. 1 foundery	Catasauqua, Pa., via N. J. C. R. R. and L. and S. R. R.
Teabo	Near Dover	Glendon Iron Co	22,468	do	Mixing for forge and foundery.	Glendon furnace, near Easton, Pa., via Mt. Hope R. R., D. L., and W. R. R. and L. V. R. R.
Hurd	Hurdtown	do	29,232	do	do	Glendon Furnace, near Easton, Pa.
Mount Pleasant	Port Oram	Executor of estate of James C. Lord.	22,525	do		Lehigh and Schuylkill valleys and Boonton, N. J., via C. R. R. of N. J., L. V. R. R., and M. and E. R. R.
Huff	do	Chester Iron Co	5,015	do	No. 2 foundery and gray forge.	Edgehill furnace, Edgehill, Allentown Iron Co., Carbon Iron Co., and Warwick Iron Co., via N. J. C. R. R. and L. V. R. R.
Ford	Jefferson township	Musconetcong Iron Works.	17,584	do	Mixing for rolling-mill and foundery.	Musconetcong Iron Works, Stanhope.
Lower Wood	Hibernia	Andover Iron Co	41,575	do	High grades of bar	Andover furnace, Phillipsburgh, via Hibernia R. R. and D. L. and W. R. R.
Allen		do	10,133	do	No. 1 forge	Andover furnace, Phillipsburg, via Mt. Hope R. R. and H. B. and N. J. C. R. R.
Washington Forge	Port Oram	R. P. Brown & Co	2,722	do		Pottsville and Allentown Carbon Iron and Pipe Co. and Cordelia Iron Co, via N. J. C. R. R, M. and E. R. R., and L. V. and L. and S. R. R.
Beers	Morris Plains	John H. Beers	22	do		Wilson's furnace, Rockaway.
Willis Hibernia	Hibernia	Bethlehem Iron Co	10,975	do	Foundery and forge	Lehigh valley region, principally own use.
Skellenger	Ironia	Thomas M. Reynolds	4,904	do	Bessemer pig	Delaware, Lackawanna, and Western Coal and Iron Co., Scranton, Pa.
Evers	Mine Hill	Saucon Mining Co	2,513	do		Saucon Mineral Co., Hellertown, Pa.
Pitney	Hacklebarney	Cooper, Hewitt & Co	2,800	do	Foundery	Pequest furnace, Pequest and Lehigh Valley furnaces, Pennsylvania.
Topping	Chester	W. J. Taylor & Co	878	do	Neutral	Chester furnace, Chester, N. J.
Brotherton	Mine Hill	George & Pullman	4,738	do	No. 1 foundery	Allentown Iron Co., Allentown, Montgomery Iron Co., Macungie Iron Co., Macungie, Carbon Iron Co., and various Pennsylvania furnaces.
Split Rock Pond	Split Rock pond	William S. De Camp	560	do		
Cobb	Split Rock	Split Rock Forge and Mining Co.	1,288	do	Boiler-plate and wire	
High Ledge	Drakesville	P. A. Freeman	1,120	do		Lehigh Iron Co., Allentown; Musconetcong Iron Co., Stanhope; Aitkin Bros., Pottsville; Thomas Iron Co., Keystone furnaces.
King	do	T. F. & W. E. King	280	do		Aitkin Bros., Pottsville, and Dauphin furnaces.
Beach	Hibernia	Andover Iron Co	357	do	Gray forge	All to Andover furnace, Phillipsburgh.
Fisher or Beattyestown.	Near Beattyestown		None.			
Nanghright	Near German valley		do			
Haun	Schooley's mountain	William W. Marsh	150	do		
Marsh	do		None.	do		
Osborne	Mount Olive		None.			
Langdon	Southwest of Chester		None.			
Hedges	Chester		None.			
Swayze	Near Chester		None.			
Squiers	do		None.			
Lewis or Herrick	Randolph township		None.			
Baker	Mine Hill		None.			
Cramer	Two miles east of Hacketstown.		None.			
Scofield	Jefferson township		None.			
Irondale	Near Port Oram		None.			
De Bow	West of Pompton Plains.	Thomas D. Hussie	112	do		

Directory of iron-ore mines—Continued.

NEW JERSEY—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	MORRIS CO.—cont'd.					
Scrub Oak	Mine Hill	Andover Iron Co	1,680	Magnetite	Gray forge	Andover furnace, Phillipsburgh.
Kahart	Pequanac township		50	do		
Dufford	Washington township.	Port Oram Furnace Co.	500	Limonite		
Howell Tract	Rockaway township.	William S. De Camp	None.			
Poole	Washington township.		None.			
Appleget	Mt. Olive township		None.			
Denmark	Rockaway township.	Jones & Fiedler	150	Magnetite		
	PASSAIC COUNTY.					
Centennial	Warwick mountain	E. H. Wright	1,340	Magnetite	Bessemer and foundery	Elmira, N. Y.; Greenwood, N. Y., and Hokendauqua, Pa., via N. Y., L. E. and W. and W. V. R. R.
Pike's Peak	Stonybrook	M. J. Ryerson	112	do	Bessemer	Bloomington forge, N. J.
Ringwood	Ringwood	Cooper & Hewitt	26,482	do		Pa. and N. J., via N. Y. and G. L. R. R., D., L. and W. R. R., and Morris Canal.
Brown	Midvale	N. Y. and N. J. Bessemer Ore Co.	1,232	do		Saucon Iron Co., Hellertown, Pa.
Wallis	W. Milford township		None.			
	SUSSEX COUNTY.					
Roseville	Roseville	Andover Iron Co	1,347	Magnetite	Bessemer pig	Andover furnace, Phillipsburgh, via Sussex R. R. and D., L. and W. R. R.
Andover Sulphur Hill	Andover	W. J. Taylor & Co	15,202	do	Bessemer	Chester, N. J., and Pottsville, Pa., via Sussex R. R., D., L. and W. R. R., and C. R. R. of N. J.
Pardee-Ogden	Sparta township	Musconetcong Iron Works.	8,089	do	Foundery or forge	Stanhope, N. J.
Sickles	Sparta	Blooming Ridge Mining Co.	1,008	do	Bessemer steel	Musconetcong furnace, Stanhope and Secaucus furnace, Secaucus, via Midland R. R. of N. J., D., L. and W. R. R., and M. and E. R. R.
Hill	Franklin	Franklin Iron Co	6,720	do	Bessemer pig	Scranton, Pa., via S. D., L. and W. R. R.
Davenport	Ogdensburgh	Aitkins Bros	1,120	do	No. 1 foundery pig	Pottsville, Pa., via O. M. R. R. and Morris canal.
Canistear	Canistear	Franklin Iron Co	10,080	do	Bessemer	Own furnace.
Pike's Peak	Franklin	do	8,960	do	Bessemer pig	Smelted by owners.
McKain	Cranberry reservoir.	Clarkson Bird	224	do		
Welling	Vernon township	M. F. Fen Eyck	168	do		
Ogden	Ogdensburgh	Atkin Bros	2,464	do	Neutral foundery pig	
William Wright	Stanhope	Smith & Rusling	2,016	do		All to Chestnut Hill furnace, Columbia county, Pa.
Manganese Iron Ore Co.	Ogdensburgh	Manganese Iron Ore Co.	10,080	do	Bessemer pig	Bethlehem, Johnstown, and Pottsville, Pa.
Brookfield or Waterloo.	Near Waterloo		None.			
Smith or Cascade	2 miles north of Waterloo.		None.			
Gafney	Byron township		None.			
Tar Hill	do		None.			
Williams	Vernon township		None.			
Pochunk	McAfee valley		None.	Limonite		
Wawayanda and Greene.	Vernon township		None.			
Hude or Stanhope	Stanhope	John M. Barns	2,887	Magnetite	Bessemer pig and foundery.	Musconetcong Iron Works, Stanhope and Port Oram furnace, Port Oram.
Green	Vernon township		None.			
Roberts	Sparta township	Allentown Rolling-Mill Co.	16,800	Magnetite		
		New Jersey Zinc Co	2,500	Zinc residues (Franklinite after extraction of zinc).		
	WARREN COUNTY.					
Oxford Iron Co	Oxford furnace	B. G. Clarke	22,359	Magnetite	Nails, foundery, and mill.	
Brown	Beattyestown	Jos. Wharton	435	Limonite	Foundery	All to Hackettstown.
Thomas	do	do	2,051	do	do	Do.
Shields	do	Musconetcong Iron Works.	9,870	do	Neutral forge and foundery.	All to Musconetcong Iron Works, via M. and E. Div. D., L. and W. R. R.
Kishpaugh	Danville	Crane Iron Co	12,711	Magnetite	Bessemer pig	Crane Iron Co., Catasauqua, Pa., via D., L. W. R. R. and L. V. R. R.
Hoagland	Near Free Union church.	Nathan Hoagland	67	do		
Confucius or Creager	Port Murry	Wright & Goulding	None.	do		Coleraine furnace.
New village	New village	Andover Iron Co	375	Limonite	Foundery	All to Andover Iron Co.

Directory of iron-ore mines—Continued.

NEW JERSEY—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	WARREN COUNTY—continued.					
Marble hill	Phillipsburgh	Henry Fulmer	None.		Steel	
Bald Pate	Port Murry	Halsey J. Boardman	165	Magnetite	Foundery pig	Cooper & Hewitt, at Durham furnace.
Rapp	Carpentersville	Andrew Rapp	392	Limonite	No. 1 pig	Andover Iron Works, Phillipsburg.
William Carpenter	do	Cooper & Hewitt	None.	do	Foundery	Pequest furnace, Pequest.
Willener & Godfray	Stewartsville	Willener & Godfray	560	Magnetite	Bessemer	Keystone furnace and Saucon Iron Co.
Davis	Independence township.	Hickok & Callahan	None.	do		
Roseberry	Belvidere	Shaw & Fry	224	do	Bessemer	Durham furnace, Durham.
Hamlen	Near Phillipsburgh	Henry Hamlen	345	Limonite	Foundery pig	Andover Iron Co., Phillipsburg.
Pequest	Pequest	Cooper & Hewitt	560	Magnetite	Foundery	
Hazard	Asbury		None.	Limonite		
Hamlen	Near Phillipsburg		None.			
Swayze	Near Hope		None.			
Marble mountain	Marble mountain		None.			
Thatcher and Stewartsville.	Franklin township		None.			
Redell	Near Oxford		None.			
Potter	Jenny Jump mountain.		None.			
Stinson	do		None.			
Howell	do		None.			
Livesey	Warrenville		None.			
Schaeffer & Gray	Independence township.		None.			
Bryant	Allamuchy township		None.			
Barker or Bulgin	Independence township.		None.			
Day	do		None.			
Wintermutes	Allamuchy township		None.			
Lawless	Byram township		None.			
Schuler	Oxford township	Cooper, Hewitt & Co.	100	Magnetite		
Riegel	Greenwich township		None.			

NEW YORK.

	CLINTON COUNTY.					
Palmer Ore-bed	Black Brook	J. & I. Rogers Iron Co.	28,000	Magnetite	Cast steel	Bethlehem Pa., Crown Point, N. Y.
Chateaugay Ore-bed	Lyon mountain	Chateaugay Ore Co	44,800		Bessemer pig	Pittsford, Vt., and Plattsburg, N. Y.
Arnold	Ferrona	Hussey & Howe M. Co., lim.	1,845	Magnetite	Pig	Clinton county, N. Y., Shenango valley, Pa., and Mahoning valley, Ohio.
Palmer	Black Brook	Penna. Iron and Steel Co.	8,670	do	Cast steel	Forge in Clintonville.
Tremblay Ore-bed	do	Peter Fremblay	1,848	do	do	Jersey City, N. J., and Pittsburgh, Pa.
Redford	Redford	W. C. Wilson	7,004	do		
	COLUMBIA COUNTY.					
Copake	Copake Iron Works.	Frederick Miles	4,480	Limonite	Car-wheel, wrought and steel.	Copake furnace.
Spathic Ore	Near Oak Hill	Thos. Rickert	None.	do	All kinds	Pennsylvania, New Jersey, and New York.
Reynolds	Ancram	Geo. Williams & Co	2,544	do		Albany, Syracuse, Irondale, Manhattanville, Chatham and Millertown, via P. H. and B. R. R. boats, and Harlem R. R.
Weed	Weed mines	do	11,200	do	Car-wheel and charcoal iron.	Albany, Hudson, Manhattanville, Chatham, and Copake Iron Works, via H. R. and C. R. R.
	DUTCHESS COUNTY.					
Fishkill	Sylvan lake	Poughkeepsie Iron Co.	18,347	Limonite	Foundery pig	Poughkeepsie.
Manhattan	Sharon station	Manhattan Min. Co	21,280	do		Manhattan Iron Works, Albany, and Burden's furnace, Troy, via Harlem R. R.
Amenia	Amenia	Amenia Min. Co	12,320	do	Car-wheels and malleable castings.	East Canaan, Conn.; Millerton Iron Co.'s furnaces, N. Y.; Cornwall Bridge, Conn.; Kent, Sharon Valley Iron Co., Lime Rock, Conn.; Manhattan Iron Co., N. Y.
Beekman	Beekmanville	A. Tower	7,364	do		
Clove	Union Vale township	Clove Spring I. Works.	19,404	do	Nos. 1 and 2 foundery and car-wheels.	Own furnaces.
Sylvan Lake	Sylvan lake	Sylvan Lake Ore and Iron Co.	16,097	do	Nos. 1 and 2 foundery and bar and car-wheels.	Troy and Clove valley, N. Y.
Dover	Dover furnace	S. Boston Iron Co	8,960	do	Guns, car-wheels, malleable and foundery.	Dutchess and Columbia counties, N. Y., and Litchfield county, Conn.

Directory of iron-ore mines—Continued.

NEW YORK.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	DUTCHESS COUNTY—continued.					
Clove	Union Vale	Fallkill Iron Co	4,517	Limonite		Poughkeepsie, via Clove Branch and Col. R. R. and Hudson River R. R.
Amenia	Amenia	N. Gridley & Son	6,160	do	Car-wheels and malleable furnace.	Furnaces at Wassaic, N. Y., Local and Hudson furnaces.
	Pawling	National Min. Co	7,280	do	Charcoal	Wassaic, Millerton, Copake, and Albany.
Riga	Mount Riga	Riga Mining Co	4,131	do	Car-wheel pig	Local, via Harlem R. R.
Horton	E. Fishhill township		None.	do		
Dakin	Northeast township		None.	do		
Maltby	Millerton	Caleb S. Maltby	None.	do	Car-wheels	Home.
Valley Pond	Pawling township	Cornelius J. Waight	None.	do		Manhattansville, N, Y.
		Francis Wister	186	do		
		Montgomery Iron Co	609	do		
	ESSEX COUNTY.					
Crown Point	Crown Point	Crown Point Iron Co	112,000	Magnetite	Bessemer, pig, and steel blooms.	Scranton and Bethlehem, Pa.
Smith	Mineville	Geo. B. Stimpson	16,800	do	Foundery, mill, lining puddling furnaces, bar and boiler plates.	Troy and Albany, N. Y., and Philadelphia, Pa.
Cheever Ore-bed	Moriah	Cheever Ore Bed Co	44,800	do	Pig and wrought	Eastern ports, via Canada, Hudson river, Long Island sound, and railroad.
Fisher Hill	do	Port Henry Iron Ore Co.	10,378	do	Bessemer pig	Albany, Hudson, and Fort Edward.
Mine 21	Mineville	do	187,448	do	Foundery castings	New York, Pennsylvania, Massachusetts, Maine, New Jersey, Ohio, Virginia, and Canada.
New Bed	do	Withbees, Sherman & Co.	31,143	do	Bessemer pig	New York and Pennsylvania, via L. C. and N. Y. and C. R. R.
Old Bed	do	do	208,416	do	Foundery, mill, forges, and lining puddling furnaces.	New York, Pennsylvania, and Ohio, via L. C. and N. Y. and C. R. R.
Barton Ore-bed	Moriah	Jas. Thomas	11,559	do	Bessemer pig, mill, and foundery.	
Lee	Port Henry	Milo J. Jermings	6,160	do	Bessemer pig	Albany, N. Y., Saint Louis, and Sharon, Pa.
Burt	Elizabeth township		None.	do		
Negrs Hill	do		None.			
Mitchell	do		None.			
Adirondack or Sanford.	Newcomb township		None.			
Paradox Lake No. 1	Schroon township	Smith & Harris	224	Magnetite		Scroon River forge.
Paradox Lake No. 2	do	Horicon Iron Co	336	do		Forge at Ticonderoga.
Minerva		H. Burden	560	do		
Keene	Keene	W. F. & S. H. Weston	1,120	do	Steel, boiler-plates, shafting, locomotives, tires, etc.	Nashua, N. H.
	Spring Hill		863	do		
	JEFFERSON COUNTY.					
White & Ward	Antwerp		None.			
Coburn	do		None.			
Old Stirling	do	Jefferson Iron Co	21,196	Hematite	Cold-blast, charcoal, pig, and car-wheels.	Eastern, western, and ourselves.
Keene	Keene Station	Rossie Iron Works	15,390	do	Foundery	Troy, Port Henry, Elmira, Ontario, and Hudson.
Shurtliff	Philadelphia	Sterling Iron Ore Co	18,991	do		Syracuse, Carthage, Port Leyden, and west.
Dickson	Antwerp	Jefferson Iron Co	8,534	do	Cold-blast, charcoal pig, and car-wheel.	Eastern, western, and ourselves.
	ONEIDA COUNTY.					
Saughlin	Westmoreland	Kirkland Iron Co	5,600	Fossil	Stove-plate	Furnace of company.
Norton & Davis	New Hartford	J. G. Egbert	3,360	do		Utica.
Klein	Verona	John Klein	280	do		Syracuse.
Caglin	do	Remous Caglin	10	do		Do.
Butler, Peck & Elliot	Clinton	Elliot, Brownson & J. E. Elliot.	11,381	do		Albany, Syracuse, and Kirkland, via D. L., W. and N. Y. C. and H. R. R. R.
Franklin Iron Manufacturing Co.	do	Franklin Iron Manufacturing Co.	16,421	do	Small castings, stove-plate, etc.	Own furnace.
	ORANGE COUNTY.					
Crawford	Sterling	Sterling Iron and Railway Co.	2,240	Magnetite	Forge and foundery pig.	
Redback or Spruce Swamp.	Near Sterling Furnace.	do	3,639	do	do	
Being	Near Sloatsburgh	do	2,688	do	do	
Ferro Hill	Warwick	M. Standish	395	do	Foundery and forge pig.	Parrott Iron Co., Greenwood.
Forest of Dean	Fort Montgomery	Forest of Dean Iron Co.	20,382	do	No. 1	Poughkeepsie, via Hudson river.

Directory of iron-ore mines—Continued.

NEW YORK—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	ORANGE CO.—cont'd.					
Scott or Oregon	Scott Mine	Sterling Iron and Railway Co.	6,477	Magnetite	Forge and foundery	
Bull	Oxford	Parrott Iron Co	2,579	do	Foundery for hardware	
Warwick	Near Warwick	do	4,464	do	Clove pig	
Hogencamp	Near Greenwood	do	11,599	do	Foundery	
Cornwall	Cornwall	Richard George	672	do	Mixture	Cold Springs, N. Y.
Taylor	Warwick township	Isaac Taylor	896	do		
Sterling, Lake, and Summit.	Lakeville	Sterling Iron and Railway Co.	26,173	do	Forge and foundery pig for lining puddling-furnaces.	Maine to Virginia and Ohio.
Parrot Iron Co			None.			
Augusta	Lorillard	Josiah Patterson	560	Magnetite		
Cunningham	Greenwood	Rich'd M. Cunningham	224	do		Durham.
		Sterling Iron and Railway Co.	1,180	do		
	Long mountain		574	do		
	PUTNAM COUNTY.					
Tilly Foster	Brewster station	Lacka. C. and I. Co	56,000	Magnetite	Bessemer pig	N. J. and Pa., via N. Y. and C. H. R. R., D. L. and W. R. R. and boats.
Brewster	do	Cheever and Durant I. M. Co.	1,344	do	Car-wheels and Bessemer	Pennsylvania, via railroad and canal.
Theall	Southeast (town)	do	2,240	do		New York, New Jersey, and Pennsylvania.
Lake Mahopac	Lake Mahopac	Richard George	896	do	Bessemer pig	Cold Springs, N. Y.
McCollum	Southeast (town)	Cheever and Durant	11,200	do	Bessemer	New York, New Jersey, and Pennsylvania.
Croft	Peekskill	W. H. Campbell	None.	do	Bessemer pig	New York state.
Todd	Campus Hollow	Fallkill Iron Co	4,032	do	Bessemer	Poughkeepsie, via C. M. R. R. and Hudson river.
	Carmel	Mahopac I. Ore Co	None.	do	Bessemer pig	
Sunk	Phillipstown and Putnam Valley.		None.	do		
Denny	Putnam Valley township.	Thomas Iron Co	84	do		
Putnam Valley		Philadelphia and R. R. and I. Co.	650	do		
		Crocker & Bro	16,823	do		
		Coplay Iron Co	72	do		
		Phœnix Iron Co	25	do		
		N. Y. and N. J. Bessemer Ore Co.	196	do		
		H. G. Nichols	285	do		
		J. L. Cunningham	45	do		
		Bethlehem Iron Co	102	do		
		Lucy furnace	123	do		
	RICHMOND COUNTY.					
Jeremiah Towle	Richmond	T. D. O'Brien	6,720	Limonite	Bessemer pig	New Jersey and Pennsylvania.
New Dorp	New Dorp	David Tyson, jr.	None.	do		Hudson river and Pennsylvania furnace.
Tyson's 4 Corners	Castleton Corners	do	224	do	Red short	Hudson river furnaces, Lehigh Valley, and Harrisburgh, Pa.
Staten Island	Ellenwood	Cooper & Hewitt	1,344	do	Bessemer	Own furnaces.
		Warwick Iron Co	24	do		
		H. G. Nichols	1,006	do		
	SAINT LAWRENCE COUNTY.					
Caledonia	Rossie	Rossie Iron Works	21,439	Hematite	Foundery and merchant bar.	Troy, Hudson, Ontario, Buffalo, Port Henry, Elmira, and New York state.
Clifton	Clifton township		None.			
Kearny	Gouverneur	John Webb, jr., & Co	8,960	Hematite	Car-wheel and foundery	Buffalo and Port Henry.
		Fullerville Iron Works.	200	do		
		Balmat & Brayton	55	do		
	WASHINGTON COUNTY.					
Potter	Fort Ann	John F. Harris & Son	12,172	Magnetite	Bessemer steel	New York state and Ohio.
Mt. Hope	do	W. P. Ostrander & Co.	6,720	do	do	J. F. Harris & Son, Fort Edward.
	WAYNE COUNTY.					
	Ontario Centre	Bundy & Co	6,944	Fossil	Rolling-mill	Buffalo and Elmira.
Wayne Co. Mining Co.	Ontario	W. S. Bartlett, St. Hill est. of E. Elliot.	29,798	do	Foundery pig	Cleveland, Ohio, Syracuse and Rochester, N. Y., and Youngstown, Ohio.
Le Frois	do	James Le Frois	4,928	do		Geddes.
Bennett Bed	Ontario Centre	Alex. Bennett	6,720	do		Do.

Directory of iron-ore mines—Continued.

NORTH CAROLINA.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	CATAWBA COUNTY.					
Forney Ore-bank	7 miles S. of Newton.	Sol. Schrum and H. A. Forney.	50	Magnetite		Local.
Kale	Catawba	Ramsaur's Forge	None.	do	Bar and plow moulds	Do.
	CHATHAM COUNTY.					
Ore Hill	Ore Hill		None.	Limonite		Richmond, Va., and other points.
	CHEROKEE COUNTY.					
Moss, Cooper & Swepson.	Valley River	Heirs of H. Moss, I. W. Cooper, and G. W. Swepson.	112	Limonite	Wrought	
Cooper & Swepson	Valley Town	Fair, Lovegood, and others.	100	do		
Montuth	Brasstown	G. A. Montuth	None.	do	Hammer bar	
Moss	Valley Town	Philip Palmer	80	do	Bar-iron	
Two Mines			224	do		
	GUILFORD COUNTY.					
Danemora	Brown's Summit	Thos. Graham	1,680	Magnetite	Bessemer and fetling	Chester, Balt., Richmond, Harrisburgh, etc.
	HARNETT COUNTY.					
Buckhorn	Buckhorn	A. I. and S. Co	None.	Specular	Bessemer pig	
	LINCOLN COUNTY.					
Big Ore bank	Iron Station	John Leonard & Co	250	Magnetite	Car-wheels, bar, and plow moulds.	
	MITCHELL COUNTY.					
Iron Mt., N. C	Rock Creek	Rees & Wilder	680	Magnetite	Cutlery and steel	Neighborhood.
		Cranberry furnace	40	do		
	SURRY COUNTY.					
Burchum & Linvil	Louis Creek	I. M. & W. A. Hiatt	100	Magnetite	Pig and wrought	

OHIO.

	SUMMIT COUNTY.					
		Akron Iron Co	17,000	Limonite		
	COLUMBIANA COUNTY.					
Hasbough	Centre township	H. H. Bowman	11,200	Limonite	Foundery, cold short	Youngstown, Ohio.
New Lisbon Min. Co.	New Lisbon	Peter Welker	3,360	do	Foundery pig	Cherry Valley furnace, Leetonia, and Himrod furnace, Youngstown.
Booth	Logtown	H. G. Booth	3,170	do	Foundery	Cherry Val. I. Works, Leetonia; Himrod furnace, Youngstown; Andrews & Hitchcock, Hubbard; and Ohio Steel Co., Lowellville.
Mathers & Greenlee	New Lisbon	Mathers & Greenlee	3,360	do	Foundery pig	Andrews & Hitchcock, Hubbard; and Himrod furnace, Youngstown.
A. G. Smith	do	A. G. Smith	10,839	do	Foundery for light castings.	Youngstown and Leetonia, Ohio.
Opey	do	John Opey	6,720	do	Foundery pig	Do.
Cairn's farm, McGavions, Shelton, Lea, Jorden, and Present	do	B. F. Lewis	7,459	do	Foundery	Do.
		Sweet & Opey	260	Limonite		
		Booth & Hardinger	1,568	do		
		Wm. H. Schmick & Co.	2,420	do		
		B. F. H. Farm	4,277	do		
		H. H. Bowman	2,315	do		
	CUYAHOGA COUNTY.					
		Glidden Eells	1,224	Limonite		
	GALLIA COUNTY.					
		Gallia furnace	680	Limonite		
	HOCKING COUNTY.					
		Crafts Iron Co	1,605	Limonite		
		Helen & Lee	16,000	do		
		Logan Iron Co	697	do		
		Thomas Iron Works	15,690	Carbonate		
		Union furnace	1,150	Carbonate and limonite.		

Directory of iron-ore mines—Continued.

OHIO—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	HOCKING COUNTY—continued.					
		E. Myres	114	Carbonate		
		Z. Nixon	176	do		
		A. H. Juniper	111	do		
		John Harvey	13	do		
		S. B. England	197	Limonite		
		E. Chute	131	do		
		Wm. Nye	46	Carbonate		
		Geo. Dyson	3	Limonite		
		Thos. Price	28	Carbonate		
		A. J. Dyson	148	Limonite		
		E. Downhorn	7	Carbonate		
		A. Norman	7	do		
		Wm. Lemon	306	do		
		John Green	10	do		
		Blackband Iron Co	4,300	Black Band		
	JACKSON COUNTY.					
		Buckeye furnace	8,900	Carbonate and limonite.		
		Huron furnace	6,900	Limonite		
		Monroe furnace	11,036	Carbonate and limonite.		
		Eliza furnace	1,000	Carbonate		
		Madison furnace	5,641	Carbonate and limonite.		
		Keystone furnace	8,000	Carbonate		
		Jefferson furnace	5,000	do		
		Gallia furnace	680	do		
			7,000	Limonite		
			5,000	Carbonate		
			2,000	do		
		C. Hainsey	260	Carbonate and limonite.		
		J. E. Goddard	175	Carbonate		
		W. J. Kirkendall	700	Limonite		
		Different persons	6,500	Carbonate and limonite.		
		Number of parties	4,031	Carbonate		
		Farmers in vicinity	600	do		
	LAWRENCE COUNTY.					
Etna Iron Works	Ironton	Etna Iron Works	22,132	do	Cold-blast car-wheels	All used at furnace.
Hecla furnace	do	Hecla Iron & Mining Co.	7,366	do	Cold-blast charcoal or any silicious ore.	Do.
Iron & Steel Co	do	Iron & Steel Co	2,169	do	Neutral pig	Do.
Buck Horn furnace	do	Campbell, McGugin & Co.	4,375	do	Cold-blast charcoal or any silicious ore.	Do.
Lawrence furnace	do	George Gray	8,224	do	Cold-blast pig	Do.
Center and Grant furnaces.	do	W. D. Kelly & Sons	12,000	do	No. 1 foundery, and charcoal.	Own furnaces.
Belfont Co	do	Belfont Iron Works Co	6,333	do	Any silicious ore	Do.
		Ohio furnace	3,241	Limonite		
		Barties Switch	783	Carbonate		
		Sundry parties	109	Limonite		
		Monitor furnace	227	Carbonate		
		Mount Vernon furnace	7,500	Limonite		
		Sarah furnace	22,500	do		
		Pine Grove furnace	8,570	do		
		Olive furnace	5,375	Hematite		
		Alice furnace	19,623	do		
		Washington furnace	5,637	do		
		Bloom furnace	300	Limonite		
	MAHONING COUNTY.					
Ohlton	Austintown	Harris, Maurer & Co	11,200	Blackband	No. 1 gray forge	Hubbard, Niles, and Hazleton.
Austin	Mineral Ridge	Todd, Wells & Co	7,921	do	Foundery	Youngstown, Hubbard, and Hazleton.
Campbell Coal Co	do	Williams & Marshall	507	do	Mixture	Hubbard and Leetonia.
		Ohio Iron and Steel Co	112	do		
		George Church & Co	896	do		
	MUSKINGUM COUNTY.					
		Zanesville furnace	8,654	Carbonate		

Directory of iron-ore mines—Continued.

OHIO—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	PERRY COUNTY.					
Bessie furnace	New Straitsville	Moss & Marshall	5,485	Carbonate	Neutral	Own furnace.
Baird Iron Co	Monday Cr. township	Baird Iron Co	5,282	do		Do.
		Winona Iron Co	1,000	do		
		S. Nummabeer	300	do		
		Horace Wilson	1,000	do		
		Peter Stimmel	500	do		
		Marsh Hillery	200	do		
		Max Hite	500	do		
		Iron Pt. Mining Co	1,134	Blackband		
		Farmers in vicinity	11,249	Carbonate		
		Vilas furnace	16,330	Blackband		
		Furnaces Nos. 1 and 2.	25,000	Blackband and carbonate.		
		Logan Iron Co	1,393	Carbonate		
	SCIOTO COUNTY.					
Howard furnace	Ironton	John Campbell	1,300	Carbonate and limonite.	Hot-blast	
		Sciota furnace	4,731	Limonite		
		do	4,224	Carbonate		
		Bloom furnace	1,100	Carbonate and limonite.		
		Ohio furnace	6,482	Carbonate		
	STARK COUNTY.					
		Volcano furnace	500	Blackband		
	TRUMBULL COUNTY.					
Osborne Coal Co	Mineral Ridge	W. H. Warner	1,680	Blackband	Stove plate, and other small castings.	Youngstown.
John Henry	do	Homer Baldwin	4,312	do	No. 1 foundery	Hazleton.
Cambria	do	Wm. T. Williams & Co.	5,043	do	American Scotch pig for foundery.	Youngstown, Hubbard, and Leetonia.
		H. H. Bowman	1,400	Carbonate		
		Hubbard furnace	300	do		
	TUSCARAWAS COUNTY.					
Blackband Iron Co	Oxford township	A. Wilhelme	1,680	Blackband	Foundery	Dover, Glasgow, and Massillon, Ohio.
Ridgeway, Burton Co.	Blackband	Ridgeway Burton Co	3,920	do	Scotch pig	Glasgow, Port Washington, and Shawnee.
Phillipsburgh	Phillipsburgh	Thos. Cox	672	do		
Catcott & Loockel	do	Ridgeway Burton Co	11,169	do	Scotch pig, foundery	Port Washington furnace, Glasgow, Ohio.
Glasgow Port Washinton Iron C. Co.	Glasgow		8,915	do	No. 1 foundery	
Kelley	Canal Dover	Hugh Kelley	4,032	do		Dover furnace.
		Dover furnace	42,000	do		
	VINTON COUNTY.					
	Line of O. and W. Va. Rwy.	J. R. Buchtel & Co	17,010	Carbonate and limonite.	Strong neutral	Line of Columbus and Hocking Val. R. R.
		Different persons	400	Limonite		
		Hamden furnace	1,090	Carbonate		
		John Frazer	300	Limonite		

OREGON.

	CLACKAMAS COUNTY.					
Prosser	Near Oswego	J. H. Pomeroy	6,972	Limonite	Stove castings and lathes, strong machinery, car-wheels, wrought and bar iron, and stamps and dies.	Oswego Iron Co.'s furnace.

PENNSYLVANIA.

	ADAMS COUNTY.					
Starner	Near Littlestown	Swartz & Boyer	560	Limonite	Foundery	Aurora furnace, Wrightsville, York county.
Guntner	do	John Guntner	None.	do	do	
	ALLEGHENY COUNTY.					
		William B. Neal	350	Carbonate		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	ARMSTRONG COUNTY.					
J. W. Baum	Goheenville	Mr. Boggs	336	Limonite		Mahoning, Pa.
J. A. Truitt	Oakland	J. A. Truitt	560	do		Kittanning Iron Co.
Mahoning furnace	Mahoning furnace	Wesley Wilson & Co.	5,600	do	Mill	All to Mahoning furnace.
Wolf	Grey's Eddy	William Atchison and Benj. McElravy.	5,040	do	Forge and foundery	Kittanning Iron Co., at Rebecca furnace. Kittanning.
Stewartson furnace	Mahoning	F. B. & A. Laughlin	None.	do	Mill and foundery	Own furnace.
		J. Richey	125	do		
		Joe Anthony	121	do		
		J. C. Rhodes	11	do		
		J. Paul	198	do		
		C. Hick	203	do		
		J. & D. Slagle	41	do		
		T. Hauk	317	do		
		C. Rhodes	606	do		
		J. A. Anthony	60	do		
		T. Snelson	117	do		
		S. C. Craigg	15	do		
		Isaac Myrete	55	do		
		William Bell	11	do		
		Jacob Duncan	143	do		
		Joseph McCoy	130	do		
		Company	62	do		
		Sundry parties	57	do		
		A. D. Hetrick	255	do		
		N. Utley	36	do		
		C. Berg	86	do		
		M. McCoy	42	ds		
		T. Nestor	37	do		
		A. Kain	121	do		
		D. Connan	17	do		
		Joe Bish	102	do		
		D. Moore	6	do		
		G. Lobaugh	55	do		
		M. Williams	17	do		
		J. Singler	1	do		
		J. Pettigrew	4	do		
		D. Bowser	6	do		
		J. McGuinnis	16	do		
		Jas. Anthony	198	do		
		E. Vickroy	255	do		
		J. Golo	279	do		
		M. Adams	136	do		
		D. Mills	345	do		
		N. M. Truitt	230	do		
		B. Coursen	70	do		
		L. W. Bish	326	do		
		J. Shook	82	do		
		S. Anderson	283	do		
		S. Cassett	8	do		
		Different parties	7,560	Carbonate		
		Number of farmers	2,576	Limonite		
		W. Brice	31	do		
		—— Allen	50	do		
		Alex. Delacore	615	do		
		R. Sharrow	67	do		
		S. Neyreth	121	do		
		C. Shook	121	do		
		J. Enty	794	do		
		E. Smelser	289	do		
		M. Buggart	553	do		
		Tone Bain	105	do		
		S. H. Craigg	330	do		
		George Neetley	583	do		
		R. T. Anthony	80	do		
		W. Barrett	260	do		
		James Nolder	26	do		
		G. Delacore	9	do		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	ARMSTRONG COUNTY—continued.					
.....	.....	P. Bish	2	Limonite	.....	
.....	.....	T. G. Craigg	243	....do	.....	
.....	.....	A. Forney	261	....do	.....	
.....	.....	B. Bell	398	....do	.....	
	BEDFORD COUNTY.					
Cambria	Hopewell	Kemble Coal and Iron Co.	1,120	Fossil	.....	Furnaces at Riddlesburgh.
No. 2	Everett	....do	550	....do	.....	Do.
Walters, Pierson, Patterson & Naugle.	Bedford and vicinity.	....do	8,997	....do	Mixture	Furnaces of Kemble Coal and Iron Co., Riddlesburgh.
Tatesville	Tatesville	....do	18,544	....do	Foundery	Do.
Cumberland	Fossilville	Cumberland Coal and Iron Co.	1,039	....do	Foundery and mill pig	Own furnace at Bowery, near Frostburgh, Md.
Cove Ore	Cove station	Robert Hare Powell	5,600	....do	Foundery, forge, and rolling-mill pig.	
.....	.....	Pennsylvania Mining Co.	172	.....	.....	
.....	.....	Sundry parties	1,347	....do	.....	
	BERKS COUNTY.					
Binder	Boyertown	Warwick Iron Co	14,409	Magnetite	Mill	Own furnace.
Boyertown	....do	Phœnix Iron Co	8,206	....do	Neutral No. 1, mill pig	Local. Own use.
Moselm	Moselm	Librandt-McDowell	5,183	Limonite	Foundery pig	Own use.
Dankles	Red Lion	Bethlehem Iron Co	6,822	Magnetite	Bessemer and spiegeleisen.	All to Bethlehem Iron Co.
Wenbling & Greiss	Long Swamp township.	....do	2,465	....do	....do	Do.
Fredericks	....do	....do	3,320	....do	....do	Do.
Weiler	Red Lion	....do	2,096	....do	....do	Do.
Sweinburtz	Seisholtzville	....do	375	Limonite	....do	Do.
Butz	Topton	....do	5,646	Magnetite	Bessemer and spiegeleisen, pig.	Do.
Moll & Geary	Rittenhouse Gap	....do	2,425	....do	Bessemer and spiegeleisen.	Do.
Fisher's	Topton	Edwin Darman	4,480	Limonite	Foundery	Carbon Iron and Pipe Co., Parryville, and William M. Kaufman, Topton.
Smith	Rhoadrocksville	Schrade & Gackenbach	2,016	....do	Foundery and mill	Coplay Iron Company, limited, Coplay.
Wheatfield	Near Fritztown	Eckert & Bro	12,672	Magnetite	....do	Used by owners.
Kohl	Durham	R. R. Bachman & Bro	1,344	....do	Bessemer steel	Home.
D. Walbert, Wy. Degely, Thomas & Mickley, Sheradin, M. Long, Drexler, Bowers, Derr, Wormkessel, B. Walbert.	Maxatawny and Long Swamp townships.	Thomas Iron Co	33,600	Limonite	Foundery and gray forge for boiler-plates, sheets, bars, car-axles, etc.	Hokendauqua and Lime Ridge furnaces.
Leibensfergen	Maxatawny	Lehigh Iron Co	1,792	....do	Foundery	
Fritz Island	Fritz Island	Reading Iron Works	2,501	Magnetite	Foundery and forge	All to Reading Iron Works.
Bushong	Reading	Bushong & Bro	353	Limonite	Foundery	Keystone Furnace Co., Reading.
Levan	Kutztown	William M. Kauffman & Co.	953	....do	Foundery pig	Topton and Kutztown furnaces.
Miller	Topton	....do	448	....do	....do	Do.
Fenstamacher	....do	....do	2,547	....do	....do	Do.
Bieber	Kutztown	....do	335	....do	....do	Do.
Mount Pleasant	Barto station	William G. Rowe	4,508	Magnetite	Foundery, mill, and Bessemer.	Danville, Pa.
Kline's Corner	Kline's Corner	Allen Schweyer	3,360	Limonite	No. 1 pig	Keystone Furnace Co., Reading.
Jones	Joanna	E. and G. Brooks Iron Co. and Phœnix Iron Co.	5,080	Magnetite	Red, short	Own furnace.
Gabel	Boyertown	Steel Ore Co	14,792	....do	Bessemer pig, car-wheels, boiler-plate, bar, and foundery.	Furnaces in Schuylkill valley, from Pottsville to Philadelphia.
Heffner	Rockland township	Frank Brownback	3,406	Limonite	Foundery	Furnaces at Lyons.
Miller	Topton	Leesport Iron Co	3,360	....do	....do	Leesport furnaces.
Udree	Oley township	Clymer Iron Co	3,002	....do	....do	Clymer Iron Co., Temple.
Heffner	Richmond township	....do	1,390	....do	Charcoal, foundery	Do.
Nathan Dresher	.....	H. B. Benfield	504	....do	No. 1 foundery	East Pennsylvania furnace, Lyons.
Weaver	Oley township	Clymer Iron Co	1,253	....do	Charcoal, foundery	Clymer Iron Co., Temple.
Chas. Falks	Long Swamp	H. B. Benfield	1,120	....do	No. 1 foundery	Keystone Furnace Co., Reading.
Trexler	....do	Trexler & Benfield	3,360	....do	No. 1	Wm. M. Kaufman & Co., Topton.
Do	Mertztown	E. H. Trexler	5,600	....do	Foundery	Keystone furnace, Reading; Reading Iron Works, Birdsborough Iron Works, and Warwick Iron Co., Pottstown.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BERKS CO.—cont'd.					
Kutz	Fleetwood	Leiss, De Long & Schweyer.	560	Limonite	Foundery and forge	Wm. M. Kaufman & Co., Topton; T. Garretson, Lyons & Temple Iron Co., Temple.
Mertzes & Kochs	do	Louis Schaefer & Co., and Geo. B. Schaefer & Co.	991	do	Car-wheel and boiler	Auburn, Schuylkill county, Reading, Oley furnace, Friedensburgh, and East Pennsylvania furnace, Lyons.
Moselm and Leesport	Moselm and Leesport	D. B. Fisher	1,539	do	Car-wheels	Leesport Iron Co., Leesport.
Miller	Topton	L. H. Leiss	2,512	do	Foundery and forge	Keystone furnace, Reading and Topton.
Mesersmith	Fleetwood	Melot & Hill	784	do	Car-wheels	Clymer Iron Co., Temple.
Alburtis	Alburtis	E. De Long	3,565	do	Foundery-pig	T. Garretson, Lyons; Keystone Furnace Co., Leesport Iron Co., and Wm. Kaufman.
Moselem Spring	Moselem Spring	H. D. Markley	1,639	do	Mill, forge, and foundery	Birdsborough and Keystone furnace, Reading.
Gregory	Near Topton	Jas. Tatham	2,353	Magnetite	Bessemer pig	Neighboring furnaces.
Daukel	Kline's Corner	H. S. Weiler	3,360	Limonite	Foundery	Topton furnace and Reading Iron Co.
Butz	Mertztown	Fitch Bros	5,096	Magnetite	do	Lyons, East Pennsylvania furnace, and Topton furnace.
Long	do	Dr. M. S. Long	3,512	Limonite	No. 1 foundery	Lehigh valley and Reading.
Schweyer & Leiss	Bower's station	Schweyer & Leiss	3,472	do	Foundery pig	East Pennsylvania furnace, Temple and Keystone, Reading, Topton and Kutztown.
Butler	do	Thos. Weaver	None.	Magnetite	Foundery and forge	Pottsville and Pottstown.
Hoches, Heffner, Miller, Gulden, and De Long.	Fleetwood, Kutztown, and Topton.	Temple Iron Co	5,602	Limonite	Foundery	All to Temple Iron Co.
Lewis	Near Mertztown	Sam'l Lewis	11,200	do	No. 1 pig	Topton, Kutztown, and Keystone furnaces, and Pottstown.
Guiterman	Seisholtzville	Morganroth & Hiteman	11,200	Magnetite	Bessemer steel	Bethlehem Iron Co.
Fenstermacher	Long swamp	Fenstermacher & De-Long.	8,960	Limonite	Foundery pig	All to Coplay Iron Works, Lehigh county.
Brownback	Near Hertzog saw-mill.	Frank Brownback	749	Magnetite	Steel	Lyons, E. Pa. furnace, Ringgold, Moselem, Sheridan, and Leesport, but chiefly to Bethlehem furnace.
Wetzel, Schweyer, Sauls, Smeyer, and Meckley.	Near Alburtis	Bethlehem Iron Co	2,502	do	Bessemer	All to Bethlehem Iron Works.
Leibensperger	Long Swamp twp	Trexler & Leibensperger.	None.	Limonite	Foundery pig	
Jones	Joanna	L. H. Smith	1,680	Magnetite	Car-wheels	
Seisholtzville	Seisholtzville	P. and R. C. and I. Co.	8,899	do	Foundery	Furnaces of Lehigh and Schuylkill valleys.
Albright	Maxatawny twp	J. G. Albright	3,041	Limonite	do	
		J. M. Reler	260	do		
		Daniel Buck	48	Magnetite		
		James T. Dunn	5	Limonite		
		J. M. Reler	233	do		
		John G. Kauffman	6,192	do		
		Theo. Bentz	42	do		
		Shaeffer & Dunn	68	do		
		L. B. Morganroth	237	Magnetite		
		John B. Fisher	318	Limonite		
		Temple Iron Co	2,382	do		
		Good & Gorin	180	do		
		Alfred Brownback	213	do		
		W. H. R. Smink	185	do		
		G. W. Hess	123	do		
		T. Garretson	151	do		
		James F. Dumm	581	do		
		David Zeigler	373	do		
		—— Morganroth	48	Magnetite		
		Jacob Gilburg	68	do		
			1,620	do		
		Frey Stahlnacker	485	do		
		Jas. F. Dunn	120	Limonite		
		Shaffer & Co	158	do		
		Seisholtzville	1,344	do		
		Moliersville	271	do		
		Bechtelsville	100	do		
		Lyons	87	do		
		J. K. Rothermel	66	do		
		A. G. Bear	10	Magnetite		
		H. Merkel	19	Limonite		
		Clymer Iron Co	114	Magnetite		
		Steel Ore Co	772	do		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	BERKS CO.—cont'd.					
		Spang & Kauffman	4,700	Limonite		
		Pottstown Steel Co	9,162	Magnetite		
		Red Lion	957	Limonite		
		J. H. Bauer	1,734	do		
		Warwick furnace	12,430	Magnetite		
		Steel Ore Co	2,121	do		
		Different parties	4,036	Limonite		
	BLAIR COUNTY.					
Short mountain	Mount Etna	Samuel Isett	336	Limonite	Foundery, castings, blooms, boiler-plate, flange, steel, and Russian sheet.	Charlotte Furnace Co., Rock Hill Iron Co., and mines.
Alleghany furnace	Logan township	S. C. Baker	6,720	do		Home.
Logan	do	do	1,120	Fossil		Do.
Bloomfield	Ore Hill	J. King, M. Lanahan	35,563	Limonite	Bessemer steel	Cambria Iron Co., Pa., Steel Co., Charlotte Furnace Co., and B. & C. Co.
Frankstown	Frankstown	Blair Iron & Coal Co	33,356	Fossil		Johnstown, Rock Hill furnace, and Frankstown.
Henrietta	Henrietta	D. Dighton Morrell	None.	Limonite		Johnstown and Frankstown.
Ore Hill	Ore Hill	Hollidaysburg & Gap Iron Co.	17,920	do	Bessemer pig	Iron works in Blair and other counties.
McKee's Gap	McKee's Gap	do	6,160	Fossil	Mill	Do.
Springfield No. 1	Mines	Cambria Iron Co	22,352	Limonite	Bessemer pig	All to C. I. Co's works, Hollidaysburg and Johnstown.
Springfield No. 2	do	do	24,159	do	do	Cambria Iron Co., Johnstown.
Springfield No. 3	do	do	7,228	do	do	Do.
	BUCKS COUNTY.					
New Tunnel	Durham	Cooper & Hewitt	4,032	Magnetite	Bessemer, for gray forge and pig.	Company's Durham furnace.
Mine Hill or Surface	do	do	5,600	do	Bessemer, gray forge for rolling-mill.	Do.
Rattle Snake	do	do	4,480	do	Gray forge and Bessemer	Do.
Boyer	do	H. Fulmer	10,080	do	Steel	
	BUTLER COUNTY.					
David M. Christy	Chartonship	Jos. Long	29	Limonite	Soft iron	Sharpsville, Ohio.
Arner Farm	Cherry township	John Spearman	49	do	do	Sharon, Pa.
Christy	Moniteau		None.		Castings	Sharpsville and Hubbard.
Bonard	New Hope	Jos. Long	1,120	Limonite		Sharpsville and Sharon.
Spearman	Near Annandale	Spearman Iron Co	1,120	do	Mill	All to company's furnace, Sharpsville.
	CARBON COUNTY.					
		Kristler & Rehria	852	Limonite		
	CENTRE COUNTY.					
Eagle Furnace	Eagle Iron Works	Curtius & Co	4,875	Limonite	Cold-blast charcoal pig, and blooms.	Company's Eagle furnace.
		Howard furnace	4,004	do		
		John Hoy	56	do		
	CHESTER COUNTY.					
Steitler	Chester Springs	Monocacy Furnace Co.	1,681	Limonite	Foundery	All to Monocacy furnace, Berks county.
French Creek		E. and G. Brooks Iron Co. and Phœnix Iron Co.	4,230	Magnetite	Red short	Company's furnace.
Warwick	Saint Mary's	L. H. Smith	1,882	do	Car-wheels	All to Joanna furnace, Joanna, Berks Co.
Hopewell	Hopewell	Pottstown Iron Co	2,446	do	Foundery, mill, and forge; pig, boiler, ship, and tank plate.	Own furnace.
Warwick Reserve	Saint Mary's	Edward Buckley	448	do	Car-wheel, pig, and boiler-plate blooms.	Own use.
		J. Jameson	1,524	Limonite		
		J. B. Stauffer	336	do		
		H. R. Anderson	705	do		
		William Weightman	265	do		
		Otto Smedely	340	do		
		Longaker & Saylor	180	do		
	CLARION COUNTY.					
Sunny Side	Sligo	Lyon & Hodil & Co	186	Limonite		Kittanning Iron Co. and Red Bank.
Vogle	Toby township	George Vogle	280	do	Pig	All to Kittanning Iron Co.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	CLARION CO.—cont'd.					
Elk City	Elk City	Kittanning Iron Co	5,040	Limonite	Forge and foundery	All to Kittanning Iron Co. at Rebecca furnace, Armstrong county.
Sligo	Sligo	do	5,040	do	do	Do.
Himes	New Bethlehem	C. E. & W. M. Andrews	455	do		Kittanning and Pittsburgh.
Truitt	do	W. W. Truitt	224	do	Gray forge and foundery.	
Fairmount	Fairmount City	Fairmount C. Co	2,800	do		Kittanning Iron Co. and Red Bank furnace.
Maclay	Piny township	D. Maclay	560	do	Pig	Kittanning Iron Co., Kittanning.
Samuel Wilson	Toby township	Craig & Rutherford	280	do		All to Kittanning Iron Co.
McGinnis	Salem	J. Bennett Macey & Co.	448	do		
Morgan	Licking township	John C. Shields	56	do		Kittanning and Red Bank.
	Toby township	Philip Benn	None.	do		Kittanning Iron Co.
	New Bethlehem	J. J. Lamberton	None.	do		
Best Farm	Edinburg	J. L. Forker	None.	do	Soft pig	
		W. B. Neal	336	do		
	COLUMBIA COUNTY.					
	Bloom furnace	Bloom furnace	7,616	Fossil		
	Irondale furnace	Irondale furnace	11,374	do		
	do	do	3,598	do		
	CUMBERLAND COUNTY.					
Carlisle	Carlisle	C. W. Ahl & Son	2,800	Limonite	Boiler-plate, sheet, pig, and car-wheels.	All to Carlisle Iron Works.
Heck	Allen township	Lewis Heck	1,120	do	Foundery and neutral	Dauphin and Perry counties.
Locust Grove	Shippensburgh	G. W. and E. Cressler	896	do	Car-wheels	Chambersburgh, Hunter and Springer; H. C. McCormick & Co., Harrisburg; Long & Johnson's, Shippensburg; C. W. Ahl & Son, Boiling Springs; and R. M. Sholter's, Carrick Furnace.
Wolf	Monroe township	Em. Wolf	1,008	do	Cold-short foundery, blooms, sheet, and bar.	Newport, Perry county.
Chestnut	Southampton township.		1,680	do	Foundery pig	Henry McCormick's, Paxton furnace, Harrisburgh.
Pine Grove No. 1	Pine Grove furnace	South Mt. M. and I. Co.	11,463	do	Neutral charcoal pig, fire-boxes, flange, and plate.	All to Pine Grove furnace.
Peach Orchard	Near Centreville	Grove Bros	125	do	Foundery and mill	Own furnace at Danville.
Beltzhoover	Boiling Springs	Phila. and R. C. and I. Co.	5,488	do	Railroad bridges, boilers, car-wheels, ordnance-rolls and cars, and heavy castings.	Reading, Danville, Harrisburg, and Dauphin.
Egé Ore-bank	do	do	23,520	do	do	Pottsville, Pottstown, Reading, Danville, and Harrisburg.
Mullin	Mount Holly Springs	Daniel King	1,792	do	Foundery and forge	Upper and lower Susquehanna.
Big Pond	Big Pond	C. W. Ahl & Son	400	do	Car-wheels	
Pine Grove No. 2	Pine Grove furnace	South Mt. M. and I. Co.	4,822	do	Foundery and mill	Harrisburg.
Calico	Near Shippensburgh	McCormick & Co	1,904	do	Neutral pig	Do.
Springfield	Near Newville	P. A. Ahl & Bro., and F. H. Thomas.	607	do	Foundery for blooms and boiler-plate.	Harrisburg furnace, Harrisburg.
Cleversburgh and Moner.	Southampton township.	Wise, Garber & Peacock.	254	do	Foundery and forge pig	Harrisburg and Marrietta.
Goodheart	Fiddler's Green	Alex. Goodheart	168	do	Foundery and forge	Ahl's furnace, Boiling Springs.
Cleversburgh Nos. 1 and 2.	Cleversburgh	P. A. Ahl & Bro	None.	do	Foundery and cold-short.	
Old Bank	South Middletown township.	D. V. Ahl	None.	do	Neutral	
Seyfut, and McManus and Lanigan.	Henry Clay station	J. E. Wynkoop and Judge Ryon.	6,781	do	Forge and foundery	Dauphin and Marshall furnace, Newport, Perry county; E. and G. Brooks, Birdsborough; Keystone furnace, Reading; and Paxton furnace, Harrisburg.
J. C. Lehman No. 2	Hunter's Run	Eisenhower & Gill	186	do	do	Marshall furnace, Newport; Swatara furnace, Denny, Watts & Co., lim., W. L. Saddler & Co., Porter furnace, Harrisburg; and Marclay, at Whitestown, Adams county.
Clover		C. W. Ahl & Son	2,832	do		
Laurel	Cook township	South Mt. M. and I. Co.	None.	do		
		H. Musselman	3,471	do		
		—— Wynkoop	198	do		
		Carlisle Iron Works	4,400	do		
	DAUPHIN COUNTY.					
Swatara	Derry township	J. & R. Meily	896	Limonite	Neutral	Own furnace.
Hershey	Hummelstown	Christian Hershey	1,120	Specular	Neutral, foundery forge, and Bessemer.	Lebanon, Harrisburg Dauphin, and Juniata.
		Cameron Furnace	1,060	Limonite		
		Christian Hershey	56	Magnetite		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	FAYETTE COUNTY.					
Lemont	Lemont furnace	Hogsett, Hanna & Co.	15,306	Carbonate	Foundery and mill	All at furnace.
Fairchance	Fairchance	Fairchance Furnace Co.	7,248	do	Mill and foundery	Do.
Mount Vernon	Mount Vernon	Charlotte Furnace Co.	12,287	do	Neutral and pig for sheet.	Charlotte furnace, Scottdale.
Dunbar Furnace Co.	Dunbar	Dunbar Furnace Co.	28,950	do	Plates, sheets, and skelps.	Own furnace.
		Farmers and others	5,376	do		
		Sundry parties	1,390	do		
		Perry Mining Co.	5,226	do		
		Sundry operators	356	do		
	FRANKLIN COUNTY.					
Benedict	Mercersburgh	J. S. Whetmer & Co.	2,800	Limonite	No. 1 foundery and Bessemer.	Harrisburg.
Richmond Furnace	Richmond furnace	R. I. Ryan & Co	2,187	do	Foundery and mill	Harrisburg and Schuylkill valley.
Cressler	Near Shippensburgh.	Hunter & Springer	3,000	do	Car-wheels and chilled rolls.	Own use.
Laural Valley	Quincy	George G. Rock	1,232	do	Car-wheels and boiler	Middletown, Chambersburgh, and Harrisburg.
Smith	Mont Alto	Smith, Duncan & Avery.	8,960	do	Neutral for pig	Middletown, Marietta, and Harrisburg.
Neikirk	Near Shippensburgh.	Isaac McHose	2,520	do	Neutral, foundery, and mill pig, hardware, stove-plates, machine-castings, boiler, ship-plates, and steel.	All to Harrisburg.
Henry Good	Quincy	Henry Good	392	do	Steam-boilers, nails, &c.	Middletown and Chambersburgh.
Mont Alto 3, 4, and 5, and Mill Bank.	Mont Alto	Mont Alto Iron Co	7,506	do	Charcoal pig, blooms, car-wheels, plate and rivet rods, and wire.	Own use and Harrisburg.
Webster	Near Mercersburgh.	C. M. Duncan & Co.	2,374	do	Pig	Sheridan, Reading, Harrisburg, Middletown, and Marietta.
Carrick	Metal township	Carrick Furnace Co.	3,360	do	Car-wheels and rolls	
Southampton	Southampton township.	L. Gochnauer	127	do	Foundery, forge pig	Marietta and Harrisburg.
Chambers	Near Scotland	T. W. Ahl	None.	do	Foundery, boiler-plate	
		C. Burkhart & Co	153	do		
		Christian Byers	56	Magnetite		
		G. A. Rock	13	Limonite		
		Henry Singer	12	do		
		R. I. Ryan & Co	1,813	do		
		McFerren Bros	109	do		
	HUNTINGDON COUNTY.					
Huntingdon county	Near McConnellstown.	Grove Bros	1,195	Fossil	Foundery and mill	Own furnace at Danville.
Brush Ridge	Brush ridge	Logan Iron and Steel Co.	6,272	do	Car-wheels and chilled rolls.	Own furnace.
Rock Hill I. and C. Co.'s mine.	Rock hill	Rock Hill I. and C. Co.	7,698	do	Gray forge pig	Do.
Shoenberger	Warrior's Mark township.	Study & Co	10,080	Limonite	Neutral No. 1 foundery and boiler-plate.	Harrisburg, Lewistown, Orbisonia, Laurelton, Scottdale, Tyrone, and Pittsburgh.
		H. Patterson	508	Fossil		
		Wisegarben & Co.	22	do		
		O. B. Crum	22	Limonite		
		G. F. Gage	16	do		
		J. H. Patterson	232	Fossil		
		Joseph Minale	67	Limonite		
	JUNIATA COUNTY.					
Yocum	Port Royal	Jacob Semon	560	Fossil	Forge	Paxton furnace, Harrisburg, Cameron Furnace Co., Middletown, Dauphin county.
Keiser Hollow and Mountain.	Four miles northwest of Mifflin.	James D. Williams	3,920	do		Harrisburg, Bloomsburgh, Dauphin, and Glamorgan Iron Co.
H. Suloff	Mifflintown	Duncamon Iron Co.	5,818	do	Foundery	Duncannon, Harrisburg, and Bloomsburgh.
Ulsh & Bros	Fermanah township.	Francis Jolls	1,792	do	Forge	Neal & Son, Bloomsburgh, Columbia county, Bloomsburgh Iron Co., Glamorgan Iron Co., Mifflin Co., and Marsh & Son, Northumberland county.
Trout Run	Four miles northwest of Patterson.	Richard Naukwell	672	do	No. 1 foundery pig	Paxton furnace, Harrisburg.
Robinson & Pennibeeken.	Mifflin	Mitchell & Naukwell	1,456	do	Mixture	Orbisonia and Harrisburg.
Slim Valley, 3, 5, 10, and 12.	Slim valley	Glamorgan Iron Co	20,160	do	Gray forge	All to furnaces.
		Frances Jowls	683	do		

Directory of iron-ore mines—Continued

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	JUNIATA CO.—cont'd.					
.....	.....	D. S. Mossen	12	Fossil	.....	
.....	.....	Emanuel Wood	75	do	.....	
.....	.....	W. E. Mankivel	30	do	.....	
.....	.....	Henry Host	550	do	.....	
	LANCASTER COUNTY.					
Grubb	Silver Spring	Chickies Iron Co	14,434	Limonite	Blooms, refined bar, hoops, boiler-plate, steel, etc.	All to Chickies Iron Co., via R. and C. R. R. and Pa. R. R.
Rakestraw	Bart	Phœnix Iron Co	1,411	do	Neutral mill, gray forge.	Own furnace.
Conestoga	Conestoga township	C. B. Grubb & Son	2,500	do	Foundery, malleable iron, bars, plate, etc.	
Chestnut Hill	Silver Spring	do	7,799	do	Foundery and mill	
Do.	Chestnut Hill	Chestnut Hill Iron Co.	13,440	do	do	Own furnace at Columbia.
Charles	Baumgardner	Keystone Furnace Co.	9	do	Foundery	Keystone Furnace Co., Reading.
Monocacy Furnace Co	Providence township	Monocacy Furnace Co.	7,840	do	Foundery or mill pig	Part to Manocacy Furnace, Berks county.
Beartown	Beartown	E. and G. Brooks I. Co.	6,818	do	Slightly cold-short	Own furnace at Birdsborough.
Mowrer, Reese, Brooks	Providence township	Peacock & Thomas	9,023	do	Foundery, strict neutral.	Own furnace at Lancaster.
Herr & Helen	Pequa and Strasburg					
.....	.....	Reading Iron Works	3,835	do	.....	
.....	.....	Charles Geiger	773	do	.....	
.....	.....	Col. Joseph D. Potts	120	do	.....	
.....	.....	J. Hildebrand	310	do	.....	
.....	.....	H. H. Lefeave	29	do	.....	
.....	.....	Vesta furnace	1,736	do	.....	
.....	.....	Donegal furnace	3,316	do	.....	
.....	.....	Joseph C. Wright	3,295	do	.....	
.....	.....	Prescott (stock ore)	2,161	do	.....	
	LAWRENCE COUNTY.					
Peter Tillia	Wampum	Peter Tillia	2,240	Limonite	.....	All to Wampum.
Ford	do	Kirkland, Fisher & Marshall.	2,800	do	Mill	Youngstown and Lowellville, Ohio.
Grains, Hawk & Co.	Chenango township	James Smith & Theo. Tilson.	None.	do	.....	
Mehard	Grand View	Lawrence Ore Co	None.	do	.....	
McClane	McClane Forn	Kirkland, Fisher & Marshall.	308	do	Foundery	Do.
Work	Wayne township	P. T. Caldwell	560	do	.....	Youngstown, Ohio.
Samuel Parker	.....	Dormon & Co	562	do	Malleable, foundery, wrought, and common bar.	Do.
Newton	Wayne township	A. G. Newton	291	do	.....	Youngstown, Ohio, and Wampum, Pa.
Bryan	Neshannock Falls	C. Bryan	10	do	.....	New Castle, Pa.
Drake	do	W. W. Drake	224	do	Common pig and wrought	Do.
Edinburgh	Edinburgh	F. M. Hoover and William Stephens.	258	do	Red-short	New Castle, Pa., and Youngstown, Ohio.
Smith	Wilmington	Wilson Drake	672	do	Common metal	New Castle, Pa.
.....	Hickory township	J. B. Hezlep	224	do	.....	Do.
D Marshall	Wampum	Kirkland, Fisher & Marshall.	84	do	Mill	Do.
Marshall	Near Wampum	Marshall Ore Co	4,480	do	Foundery and mill	Wampum and Youngstown.
Freshkorn	Wayne township	John Freshkorn	8,960	do	Open iron	Lowell, Ohio, and Wampum furnace.
Hope	Rose Point	Hope F'ce Co., lim	10,080	do	Cold-blast charcoal, boiler, bars, and steel.	All to own furnace.
Orchard, D. F. Houk, Broad, Ford & Works.	Wampum	Lawrence Ore Co., lim.	28,448	do	Foundery and mill	Youngstown, Ohio, used by owners.
.....	.....	Sundry parties	4,500	do	.....	
.....	.....	George Pearson	817	do	.....	
.....	.....	Geo. W. Johnson & Co.	673	do	.....	
.....	.....	Alford & Stickle	211	do	.....	
.....	.....	Sundry parties	2,410	do	.....	
.....	.....	Peter Boyle	252	do	.....	
.....	.....	Sundry parties	1,232	do	.....	
	LEBANON COUNTY.					
Cornwall	Cornwall	Cornwall Ore Bank Co.	280,000	Magnetite	Red-short, Bessemer steel, mill, nails, etc.	Home and a radius of 75 miles.
Bowman	do	Eckert & Bro. and Reading Iron Works.	1,275	Limonite	Foundery and forge	All used by owners.
Strickler	Jackson township	E. & G. Brooks Iron Co	1,672	do	Foundery pig, slightly cold-short.	Own use at Birdsborough.
Bucher	Near Prescott	Temple Iron Co	2,681	do	Foundery and forge	Own use.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	LEHIGH COUNTY.					
Shantz & Christman	Emaus, Macungie	Colleraine Iron Works	2,800	Limonite	Foundery pig	Do.
Jacobs	Alburtis	Bethlehem Iron Co	8,720	Magnetite	Bessemer iron and spiegel-eisen.	All to Bethlehem Iron Co.
E. & G. Brooks	Macungie	do	2,101	do	do	Do.
Foster	Shimerville	do	320	do	do	Do.
Wm. H. Clymer & Co.	Macungie	do	949	do	do	Do.
William Newmoyer	Alburtis	do	945	do	do	Do.
Jacob Newmoyer	do	do	418	do	do	Do.
Hensinger	do	do	1,861	do	do	Do.
Diehls	Emaus	do	853	do	do	Do.
Lawrence	do	do	198	do	do	Do.
Siegers	Siegersville	do	6,028	Limonite	Foundery and forge	L. V. region, principally for own use.
Lauer	Hensingersville	do	3,453	do	do	Do.
Peter Fregely, John Bortz, Hing. Fautz, John Hensinger, H. J. Schmoyer, A. D. Morey, William Fogel & N. Fitch.	Allentown	Boyer & Shaffer	14,560	do	Wrought	Allentown Rolling Mill Co., Thomas Iron Co., Hokendauqua, Carbon Pipe and Iron Works, Parryville, W. M. Kaufman & Co., Topton & Macungie Iron Co., Millerstown.
Albright, Krames, Bortz, Acker, Roans, and Christmans.	About Allentown	do	13,657	do	Foundery and mill	Company's furnace, Allentown.
No. 1 and Kennel	Ironton	Ironton R. R. Co	4,465	do	Foundery	Coplay.
Laros	Upper Macungie	Jesse Laros	5,094	do	Foundery, anthracite pig	Catasauqua.
Shimers	Shimerville	H. H. Hartzell	1,680	Magnetite	Bessemer and foundery	Macungie and Catasauqua.
Wenner's, Wieand's, Swartz & Kemmerer, Dankel, Glicks, Dech & Romich, Roth, Keck, Merkel, Kline, Wickert, Lichtenwallner, Warmkessel, Fritch, Herzog, Beek, Shulers, Danner, and Fisher Bros.	Near Allentown	Allentown Iron Co	43,616	Limonite	No. 1 foundery	Allentown Iron Co.
Marks	Upper Macungie	Falstich Sell Co	4,480	do	Foundery	Crane Iron Co., Catasauqua.
Swartz	Wescosville	J. H. Hall	1,633	do	Pig	Allentown, Catasauqua, Hokendauqua, and Macungie.
Smith	Near Fogelsville	W. Shanksweiller	442	do	Foundery pig	Own furnace.
Levi Lichtenwalner	Upper Macungie township.	Crane Iron Co	4,630	do	Foundery pig, anthracite.	Own furnace at Catasauqua.
Ritter	North Whitehall	do	11,473	do	Anthracite	Do.
Woch	Hanover	do	2,288	do	Anthracite pig	Do.
Ruch	North Whitehall	do	4,010	do	do	Do.
Gachenbach	Lower Macungie	do	5,105	do	do	Do.
Lichtenwalner	Upper Macungie	do	3,290	do	do	Do.
Ziegler	Lower Macungie	do	5,132	do	do	Do.
Butz	do	do	1,142	do	do	Do.
Neumeyers	Near Macungie	W. Shanksweiller	84	do	Foundery	Own furnace.
Steininger, Getz, Abra. Schmoyer, Singmaster, R. Butz, M. & D. Butz, Meitzler, Mosser, Lorish, Bastian, Levans, Kline, Hensinger, Ballict, Shaadts, Guths, Wenner, Bahls & Steine.	Upper and Lower Macungie, and Whitehall twps.	Thomas Iron Co	33,600	do	Foundery, gray forge, boiler-flues, plates, sheets, bars, car-axles, etc.	Hokendauqua and Lock Ridge furnaces.
Schmoyer	Emaus	Lehigh Iron Co	3,584	do		Own works at Allentown.
Butz	Alburtis	Lehigh Iron Co	2,464	do	Foundery	Lehigh Iron Co.
Setzel	Shereville	Thos. Rutt	1,714	do	do	Lehigh Iron Co., Allentown.
Maistellar	Alburtis	Bethlehem Iron Co	None.	Magnetite	Bessemer and spiegel-eisen.	
Greenawalt	Centre Valley	Woodring & Musselman.	1,792	Limonite	Foundery and forge	Carbon Iron Co.
Lichtenwallner	Upper Macungie	E. P. Lichtenwallner	7,840	do	Foundery	Crane Iron Co., Catasauqua.
Jonas Schmoyer	do	O. J. Schmoyer	3,900	do	do	Thomas Iron Co., Lock Ridge and Carbon Iron and Pipe Co., Parryville.
Schwartz	Wescosville	I. H. Kalb	4,480	do	do	Crane Iron Co., Catasauqua, Thomas Iron Co., Hokendauqua, Macungie Iron Co., Macungie.
Wind	Centre Valley	—— Miller	560	do	No. 1 gray pig	Saucon furnace, Carbon Iron and Pipe Co., limited, and Coleraine Iron Works, Redington.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	LEHIGH CO.—cont'd.					
Jordon	Guth's station	Carbon Iron and Pipe Co.	3,862	Limonite	Nos. 1 and 2 foundery	All to Carbon Iron and Pipe Co., Parryville.
Meitzler	Alburtis	John G. Kauffman	903	do	No. 1 foundery, anthracite, and charcoal pig.	Alburtis.
Barner & Garmer	Macungie	Leesport Iron Co	3,360	do	No. 1 foundery	All to Leesport furnace.
Kurtz	Upper Saucon	Saucon Iron Co	280	do	Foundery and forge	
Adams & Pascoe	Spring Valley	Adams & Pascoe	1,680	Magnetite	Bessemer steel	Bethlehem Iron Co., Bethlehem.
Klein	Hoffmansville	John Klein	3,024	Limonite	Foundery	Thomas Iron Co., Hokendauqua.
Balliet, heirs	Ironton	Horace Balliet & Son	5,600	do	Foundery pig	Coplay Iron Co.
Wickert, Shuler & Bandert.	Near Vera Cruz	Pascoe, Lewis & Co	6,720	Magnetite	Bessemer steel and railroad.	Bethlehem Iron Co., Coleraine Iron Co., and others on Lehigh river.
Pascoe & Webb	Upper Milford	Pascoe & Webb	1,344	do	Bessemer steel	All to Bethlehem Iron Works, Bethlehem.
Jobst	Macungie	F. T. Jobst	3,360	Limonite	Foundery	Macungie and Thomas Iron Co.'s. Furnace at Lock Ridge.
Belton & Steiningen	Upper Macungie	Thos. Breining	5,600	do	do	Thomas Iron Co., Hokendauqua.
Fry, Keely & Finks	Near Vera Cruz	Pascoe, Schwartz & Bauden.	10,080	Magnetite	Bessemer pig	Bethlehem and Coleraine Iron Works, and Dauphin and Moselem furnaces.
Newmeyer	Lymport	Edwin & Isaac Newmeyer.	3,360	Limonite	No. 1 Foundery	Carbon Iron Co., Parryville, Topton, and Lyons, East Pennsylvania furnace, and Schuylkill valley furnaces.
Meckley	Alburtis	C. A. Gernerd	1,606	do	Foundery	Crane Iron Co., Catasauqua.
Fry & Stahlnecker	Vera Cruz	Fry & Stahlnecker	4,320	Magnetite	Bessemer pig	Coleraine Iron Co., James Hoover & Son, Morristown, and others.
Henry	Near Siegersville	Danl. Henry	616	Limonite	Foundery pig	Coplay Iron Co., limited.
Hensinger & Saul	Hensinger's hill	P. N. Hensinger	1,680	do	No. 1 pig and steel	Reading and Hokendauqua, Thomas Iron Co., Keystone Furnace Co., Reading, and Coleraine Iron Co.
Stephen Butz	Alburtis	Butz & Lichtenwallner.	1,344	do	Foundery pig	Crane Iron Co., Catasauqua and Thomas Iron Co., Hokendauqua.
Brown Bros	Near Ironton	Brown Bros	11,716	do	do	Thomas Iron Co., Hokendauqua.
Erdman & Cooper	Upper Saucon township.	Enos Erdman	2,617	do	do	Carbon Iron Co., Parryville.
Knauss	Emaus	Coleraine Iron Works	784	do	do	Coleraine Iron Works.
Ziegler	Near Topton	Temple Iron Co	5,831	do	do	All to Temple Iron Works.
Kiefer	Near Whitehall township.	Jos. Kiefer	8,960	do	do	All to Coplay Iron Works, Coplay.
Hiram Balliet	Saegerville	Hiram Balliet	5,370	do	Foundry	Thomas Iron Co., Hokendauqua,
Andrews & Shuler	Lower Macungie	Andrews & Shuler	4,480	do	do	Macungie furnace, Thomas Iron Co.
Balliet Bros	Ballietsville	Balliet Bros	6,720	do	do	Coplay Iron Works and East Pennsylvania Charcoal furnace near Parryville.
Mickley	Whitehall township	Coplay I. Co., limited	None.	do	Foundry pig	
Eisenhart	Lower Macungie	do	None.	do		
Singmaster & Greiss and John Wetzel.	Near Alburtis	Bethlehem Iron Co	742	Magnetite	Bessemer	Bethlehem Iron Works.
		Kratzer & Weir	436	Limonite		
		Sam'l Fluck	234	do		
		Wm. B. Shaeffer	206	do		
		Sims & Wagner	214	do		
		Wm. Clader	24	do		
		Chas. Maddern	41	do		
		Beidler & Smayer	43	do		
		Jacob Fluck	58	do		
		Frantz Kemerer	9	do		
		Tilghman Stetler	9	do		
		Sol. Steidinger	2	do		
		Benj. Schmoyer	1,199	do		
		Stephens & Ritter	3,216	do		
		C. A. Gunera	1,463	do		
		H. K. Hartzell	1,223	do		
		Simon Schmoyer	1,407	do		
		R. W. Pascoe	4,673	Magnetite		
		Lewis, Schwartz & Co.	618	do		
		Dan'l Guth's heirs	930	Limonite		
		Guth & Litzenbergen	384	do		
		B. P. Schomoyer & Bro	3,952	do		
		W. A. Ricker	2,294	do		
		Lawer & Shuler	2,227	do		
		John Johaning	1,011	do		
		G. G. Greiss	2,300	do		
		Henry Stine	1,054	do		
		Ritter & Seam	407	do		
		Miller & Mickley	501	do		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	LEHIGH CO.—cont'd.					
.....	.....	Chas. Lichtenwallner	559	Limonite	.....	
.....	.....	Ritten & Shankweiler	548	do	.....	
.....	.....	J. J. Woodring	105	do	.....	
.....	.....	L. Fisher	8	do	.....	
.....	.....	Sol. Boyer	11,554	do	.....	
.....	.....	S. Smoyer	609	do	.....	
.....	.....	H. Shankweiler	370	do	.....	
.....	.....	S. Laudenslayer	480	do	.....	
.....	.....	Allentown rolling-mill	20,893	Magnetite	.....	
.....	.....	D. E. Lewis	507	do	.....	
.....	.....	Wm. Hubeastump	23	do	.....	
.....	.....	Chas. Neiver	2,038	Limonite	.....	
.....	.....	Sam'l Culver	1,994	do	.....	
.....	.....	Sol. Dorney	599	do	.....	
.....	.....	Jno. K. Beiler	602	do	.....	
.....	.....	Sylvester Beiber	392	do	.....	
.....	.....	Bernhardt E. Fernow	56	do	.....	
.....	.....	Jesse Straub	99	do	.....	
.....	.....	Weiler & Breinig	213	do	.....	
.....	.....	Geo. W. Ruth	206	do	.....	
.....	.....	Tatham Bros	11	Limonite	.....	
.....	.....	Long & Swoyer	22	do	.....	
.....	.....	Trerbertown wharf	11,831	do	.....	
.....	.....	Weilen & Shaeffer	957	do	.....	
.....	.....	Center Valley	7,423	do	.....	
.....	.....	Weckel & Spogen	902	do	.....	
.....	.....	Tegeley & Weaver	112	do	.....	
.....	.....	David Thomas	307	Magnetite	.....	
.....	.....	N. Hunter	446	do	.....	
.....	.....	Different parties	4,223	Limonite	.....	
	LYCOMING COUNTY.					
Quiggle	Quiggleville	Wm. Bowers	112	Fossil	Merchant iron	Columbia and Montour.
Bald Eagle	Near Jersey Shore	Grove Bros	356	do	Foundery pig	Own furnace at Danville.
Bald Eagle and Lycoming.	Jersey Shore	J. Humes	4,480	do	Rolling mill and foundery.	Danville, Bloomsburg, and Northumberland.
Red Run Coal Co	Near Roaring Branch	Atlas Iron Co., (lim.)	None.	Carbonate	Car-axles and wheels	
.....	.....	Creveling, Miles & Co.	202	Fossil	.....	
.....	.....	Hayes & Bowen	113	do	.....	
.....	.....	John Knight	111	do	.....	
	MERCER COUNTY.					
.....	.....	Cheshire Iron Co	1,008	Carbonate	.....	
	MIFFLIN COUNTY.					
Shehen	Oliver township	George Shehen	903	Limonite	.....	Orbisonia Iron and Coal Co., William Neal & Sons, Bloomsburgh.
Jack No. 2	McVeytown	William P. Stevenson	1,400	Fossil	Foundery	
Hancock & Bright	do	do	1,366	Limonite	Foundery and tough castings.	
Joe	do	do	672	do	.....	
.....	Matilda furnace	Peacock & Thomas	1,120	Fossil	Foundery and forge	All to own furnace.
McKee	Strode's mills	Fred. Hanke	3,360	do	.....	Bloomsburgh, Lewistown, Orbisonia, and Harrisburg.
Ruport	Oliver township	Samuel Brewer	262	do	Gray forge pig	Rock Hill furnaces, Orbisonia.
Harsbarger	Bratton township	David Harsbarger	92	do	do	Orbisonia.
George Strode and G. A. Leopold.	Near Three locks	Howard Lewis	1,456	do	do	Rock Hill and Harrisburg.
Miller	Mattawana	William Miller & Bro.	336	do	do	Orbisonia and Harrisburg.
Settle	Strode's mills	George Settle	1,120	do	Gray forge	Mr. Simms, Orbisonia.
O'Connor	McVeytown	Mrs. S. F. O'Connor	728	Limonite	Foundery pig	Bloomsburg, Lewistown, and Mount Union.
Cavenaugh 1 and 2	Cavenaugh	Glamorgan Iron Co	7,840	Fossil	Gray forge	Own furnaces at Lewistown.
Squaw Hollow 1 and 2	Squaw Hollow	do	12,320	Limonite	do	Do.
Shehen	Oliver township	George Shehen	1,177	do	Cold-short	All to Orbisonia Iron and Coal Co.
.....	.....	Glamorgan Nos. 1 and 2	7,073	do	.....	
.....	.....	do	10,787	Fossil	.....	
.....	.....	J. G. McCoy	50	Limonite	.....	
.....	.....	John Rupert	1,060	Fossil	.....	
.....	.....	Bradly & Dule	77	Limonite	.....	
.....	.....	J. G. McCud	500	Fossil	.....	

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	MONTGOMERY COUNTY.					
Geo. Keys	White Marsh township.	Geo. Keys	672	Limonite	Foundery pig	Marion and Elizabeth f'ces, Conshohocken.
Yeakle	Five Points	Lukens & Yeakle	5,600	do	No. 1 foundery	Schuylkill valley.
Hallman	Plymouth township.	Wm. A. Hallman	672	do	Foundery pig	Marion and Elizabeth f'ces, Conshohocken.
McGuirk	Flourtown	Richard McGuirk	1,120	do	do	Pottstown Iron Co.
Yeakle Farm I. Ore Co.	do	Robt. McGuire	5,600	do	do	Pottstown, Port Kennedy, Monocacy, and Schuylkill valley furnaces.
Heydrick	do	Wm. H. H. Heydrick	2,800	do	do	Schuylkill valley furnaces, Plymouth, Port Kennedy, and Warwick.
Wilson	Edge Hill	S. M. Wilson & Bro	8,400	do	do	Edge Hill Iron Co. and Plymouth furnace, Conshohocken.
Edw. McAttee	Flourtown	Edw. McAttee	784	do	do	Marion and Elizabeth f'ces, Conshohocken.
Aiman	Edge Hill	Jas. Harvey	672	do	Gray forge	Ege Hill furnaces, Schuylkill valley.
McClusky & Sweeny	Flourtown	McClusky & Sweeny	1,120	do	No. 1 foundery	Conshohocken and Norristown.
Kane & Engle	Barren Hill	Kane & Engle	2,352	do	do	D. O. Hitner, Wm. Penn f'ces, Spring Mill.
D. O. Hitner	Spring Mill		8,841	do	Forge and foundery	All to D. O. Hitner's furnace, Spring Mill.
Hitner	Marble Hall	Dan'l Hitner	448	do	do	Do.
Orbison	Plymouth	Thos. J. Hayden	784	do	Gray forge	S. Fulton, Conshohocken.
Tracy	Near Conshohocken.	John Tracy	2,016	do	No. 1 foundery	Marion and Elizabeth f'ces, Conshohocken.
		Hayden & Davis	506	do		
		J. Murphy	21	do		
		P. Fritz	11	do		
		Broderick & Kennedy	592	do		
		—— McFadden	665	do		
		Chas. Streeper	156	do		
		Brown & Staley	1,006	do		
		Dutturer & Bickings	150	do		
		G. W. Hacker	162	do		
		D. Staley	41	do		
		Geo. Thornton	12	do		
		Geo. Dutturer	43	do		
		J. C. Dutturer	36	do		
		Linley Staley	37	do		
		G. W. Foreas	628	do		
		Kline & Baker	242	do		
		Meeney & McGraus	441	do		
		Chas. Staley	44	do		
		Engle & Rex	96	do		
		Hitner Bros	160	do		
		James Sampson	490	do		
		Geo. Hullman	203	do		
		J. Engle	279	do		
		Carn & Dutturer	329	do		
		Carn & Bros	566	do		
		J. Hiltner	11	do		
		E. Staley & Co	375	do		
		Bowman & McLean	78	do		
		Staley & Hiltner	376	do		
		Foster & Kephart	69	do		
		P. W. Morris	234	do		
		do	1,504	do		
		Norristown furnace	4,504	do		
		Phœnix Iron Co	7,500	do		
		H. Hydrick	2,000	do		
		Sundry persons	4,000	do		
		James Hoover & Son	4,504	do		
		—— McGuillan	900	do		
		Sundry Persons	1,562	do		
		Patrick Kelly	1,029	do		
		Patrick Campbell	319	do		
		John Jacoby	3,618	do		
		J. O. Richardson	919	do		
		Jas. Beatty	74	do		
		Jerome Keeley & Co	111	do		
		W. W. Robbs	85	do		
		Sam'l C. Rover	54	do		
		Sam'l Heston	143	do		
		Various parties	5,824	do		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	MONTGOMERY COUNTY—continued.					
		Chas. Sweeny	900	Limonite		
		Steel Ore Co	355	do		
		Different operators	2,550	do		
		Sundry parties	2,000	do		
	MONTOUR COUNTY.					
Welch Hill No. 3	Danville	Montour I. and Steel Co.	7,370	Fossil	All grades of pig for rails.	Own furnaces.
Giger	Near Danville	Grove Bros	93	do	Foundery and mill pig	Own furnaces at Danville.
Reich	do	do	None.	do	Foundery pig, and mill	Do.
Block	Danville	Montour I. and Steel Co.	None.	do	All grades of pig	Own furnaces.
Drift No. 5	Valley township	do	39	do	do	Do.
Pursel	do	do	12,100	do	do	Do.
Frosty Valley	do	do	5,013	do	All grades of pig and rails.	Furnaces at Danville except small lots.
Moore	West Hemlock	do	None.	do	All grades	Own furnaces.
Welch Hill No. 13	Danville	do	3,250	do	All grades of pig for rails.	Do.
Magill	do	Grove Bros	2,736	do	Foundery and mill pig	Own furnaces at Danville.
Liberty	Near Mooresburg	R. M. Cummings	140	do	Mixture	Northumberland, Danville, and Bloomsburgh.
		Wm. Painter	22	do		
		Datesman Son, Williams.	300	do		
		Cole Brothers	398	do		
		Joseph Hubbs	147	do		
		John S. Hartzell	2	do		
		Samuel Samesberry	202	do		
		William Amesberry	71	do		
		Henry Schram	22	do		
		George Leighow	3	do		
		J. Lazarus	3	do		
		William Gething	11	do		
		Joseph Marr	64	do		
		G. W. Rishel	8	do		
		Sylvester Sandus	1	do		
		F. E. Mons	82	do		
		F. Sloch	53	do		
		P. Stell	1	do		
		E. Jones	56	do		
		G. W. West	10	do		
		James Jeffras	1	do		
		Lawrence Marr	10	do		
		Andrew Homer	2	do		
		Waterman Co	1,680	do		
	NORTHAMPTON COUNTY.					
Brotzman	Williams township	Glendon Iron Co	5,040	Limonite		
McKeen, Diche and Notting Mill.	do	do	2,016	do		
Mary Wotting, Naef & Peifer.	do	do	2,968	do		
D. Runkle & Co	do	D. Runkle & Co	416	do	Foundery and forge	Company's furnace.
Hahn	do	Stephen Ackerman	672	do		Glendon Iron Co., Moselem.
Shortz & Coleman	Nazareth	Schleicher & Bro	8,004	do	Foundery and mill	Own use and Carbon I. and Pipe Co.
Shortz	Hanover	Crane Iron Co	1,757	do	Anthracite, foundery, and pig.	Company's furnace, Catasauqua.
Hahn	Williams township	Hahn & Bro	7,675	do		Glendon Iron Works.
Leich	East Allen	Crane Iron Co	7,200	do	Foundery and anthracite pig.	Company's furnaces, Catasauqua.
Walter, Aten & Hess	Williams township	Glendon Iron Co	672	do		
Jones & Kœnig	Palmer township	do	4,592	do		
Sampson	Cedarville	Sampson & Bro	2,330	do	Soft, tough iron	Glendon Company's furnace, Glendon and South Easton, Pa.
Richards	Glendon	Thomas Richards & Son.	9,748	do	No. 1 foundery	Keystone Furnace Co., Glendon.
Walters Hematite	Williams township	Cooper & Hewitt	1,680	do	Foundery and gray forge	Durham furnace.
Vacht	do	R. B. Bachman & Bro	411	do	Ordinary pig	Do.
Ivey	Coffeetown	Isaac Ivey	5,852	do	No. 1	Glendon and Durham.
Smith & Kleinhan	Cedarville	Charles Sheets	1,344	do	All kinds	Glendon Co. and Thomas Iron Co.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	NORTHAMPTON CO.—Continued.					
Kichlein	Glendon	Charles Kichlein	3,696	Limonite	No. 1 foundery	Keystone furnace and Glendon Iron Co.
Brotzman	Near Glendon	Peter Peifer	2,240	do	Foundery	Glendon Iron Co.
Thomas Yeisley	Glendon	Thomas Yeisley	1,008	do	No. 1 foundery	Glendon Iron Co., and Keystone furnace near Easton.
Eckman	Cedarville	Henry Peard	1,008	do	Foundery pig	Glendon Iron Co.
George W. Unangst	Glendon	George W. Unangst	1,008	do	No. 1 foundery	Do.
Lewis	South Easton	Sidney Sandt	672	do	Foundery	Lucy and Keystone furnaces and Glendon Iron Works.
Wharton	Lower Saucon tw'p	Saucon Iron Co	8,653	do	Foundery and forge	
Bingen	Bingen	do	2,270	do	do	
Gangivere, Reigel & Bro.	Saucon township	Coleraine Iron Works	7,840	do	Foundery pig for stoves and machinery castings.	Own furnaces.
J. P. Keohler	East Allen township	C. & H. Slade	3,010	do	Foundery	Thomas Iron Co., Hokendauqua.
Engler	Bethlehem tw'p	Peter Engler	448	do	Foundery and forge	Carbon Iron Co., limited, Parryville.
B. C. Walters	do	Dr. B. C. Walters	1,244	do	do	Do.
Jacob Beck	Nazareth	Schleicher & Ecker	1,680	do	do	Do.
Lawall	Lower Nazareth	Ritter & Love	2,016	do	do	Carbon Iron Co., limited, and Lucy furnace, near Easton.
Unangst	Coffeetown	William Taylor & Son and Adam Deal.	148	do	Foundery and forge pig	Cooper, Hewitt & Co., Durham Iron Works.
Hoover	do	Jacob Lest	704	do	do	Durham Iron Co. and Glendon Iron Co.
Koekler	Hanover township	Saucon Iron Co	4,542	do	do	Saucon Iron Co.
Hummel	Near Nazareth	Dennis & Weaver	224	do	do	Carbon Iron Co.
		William Chapman	2,974	do		
		John Wetzel	732	do		
		Syl. Merwurth	182	do		
		John Best & Co	214	do		
		Adam Hahn	1,113	do		
		Mrs. Richards, jr	461	do		
		Peter Moser	321	do		
		Leidick & Derr	55	do		
		Bushkill Iron Co	360	do		
		Samuel Heller	195	do		
		C. A. Mauch	2,371	do		
		Ivey & Transue	352	do		
		Henry Brinfield	1,014	do		
		Brodhead wharf	7,395	do		
	NORTHUMBERLAND COUNTY.					
Chulasky	Chulasky	Creveling, Miles & Co.	896	Fossil	Foundery and forge pig for rails.	Chulasky furnace.
Montandon	Near Montandon	R. M. Cummings	1,120	do	Mixture	Northumberland, Danville, and Bloomsburgh.
		Chulasky	1,471	do		
		Frances furnace	1,978	Limonite		
		M. C. Tate	168	Fossil		
		Butler & Cumings	196	do		
		James Beacham	314	do		
	PERRY COUNTY.					
	Centre	Valentine & Co	11,200	Limonite	Car-wheels, boiler-plate, wire billets, rods, tools, scythes, hoes, and shovels.	Own furnace, and Elmira, N. Y.
Beaver, Marsh & Co. and Levi Rooke & Co.	Millerstown	James Rounsley	11,200	Fossil	Foundery and gray forge.	Harrisburg, Bloomsburgh, Union furnace, Lewisburg.
Clouser	Lime Ridge	Elias Fisher	1,344	Limonite	Foundery	Marshall furnace, Newport, Pa.
Cochran Mining Co	Millerstown	Robert P. Cochran	3,584	Fossil	Sheet-iron	Reading, Pa:
Patton Iron Works	do	J. D. Williams	3,752	do	Foundery and forge pig.	Lochiel furnace, Harrisburg.
Jones & Co	do	Rinehart & Jones	2,240	do	Mill and forge	McCormick & Co., Harrisburg, and Marshall Brothers, Newport, Pa.
Mochonay & Jones	Mochonay Valley	Henry Stites	67	do	Foundery pig	Bloomsburgh Iron Co. and Dauphin furnace.
Kremer	Tuscarora township	Coombs & Kepner	2,208	do	Forge and foundery pig.	Denny Watts & Co., lim., and Swatara furnace.
Rice	Donally's Mills	Nankirell & Pellow	3,474	do	Foundery and forge	All to McCormick & Co.'s Paxton furnace, Harrisburg.
Mahanoy	Mahanoy valley	John B. Hartzell	84	do	Mixture	
		Williams & Nayhide	41	do		
		D. K. Reeder	190	Limonite		

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	SNYDER COUNTY.					
Beavertown	Beavertown	Moses Spicht	4,869	Fossil	Forge	Bloomsburgh, Glamorgan Iron Co., Lewistown and Fredonia furnace.
Three mines	Vicinity of Adamsburgh.	Dr. A. M. Smith	8,960	do	Mixture	Bloomsburgh Iron Co., Bloomsburgh, and Glamorgan Iron Co., Lewistown.
Mengel	Middleburgh	John Mengel	1,344	do	Foundery	Bloomsburgh and Danville.
Weller	Washington township.	Peter Weller	1,344	do	Pig	Bloomsburgh and Danville, etc.
Ore Mine	Kreamer	Andrew Bickel	1,232	do	Wrought or pig	Mostly to Bloomsburgh.
Dreesis Boys, Ruben Dreesis, Mrs. Shirey, Abner Middlesworth, Rooke & Swengle, Bucher & Swengle, Felker & Mitchell.	Adamsburgh and Beavertown.	Charles P. Swengle and Rooke & Bucher.	4,032	do	No. 1	Union furnace, Winfield, Danville, Bloomsburgh, and Lewistown.
J. D. Conrad, Bowersox, Hook and Bloomsburgh Iron Co.	Beaver and Franklin townships.	J. D. Conrad	5,600	do	Iron for machine-shops	Bloomsburgh, Creveling, Miles & Co.; Danville, Painter of Danville; and Glamorgan Iron Co., Lewistown.
		Simon Kubs	1,012	do		
		S. H. Yoder	13	do		
		J. J. Mitchell	96	do		
		A. G. Ensenhart	26	do		
		Yoder & Meisser	14	do		
		D. L. & W. R. R	148	Magnetite		
		R. G. Eisenhart	12	Fossil		
		Creveling, Miles & Co., lim.	907	do		
		N. W. Smith	104	do		
		Simon Krebs	164	do		
		Mitchell & Field	22	do		
		Wm. Y. Cruikshank	679	do		
		Roush & Bickel	505	do		
		Samuel Weller	111	do		
		Elim Specht	30	do		
		J. G. Moyer & Co	60	do		
		Specht & Greenhoe	51	do		
		J. R. Keeler	90	do		
	TIOGA COUNTY.					
Mansfield	Mansfield		None.	Fossil	Foundery	
		Mansfield furnace	100	do		
	UNION COUNTY.					
	Lawson Switch	M. C. Tate	529	Fossil	Foundery pig	Bloomsburgh, Danville, and Northumberland.
		Jas. S. Marsh	146	Limonite		
		G. W. Walls & Co	13	Fossil		
		Smith, Blair & Co	120	do		
	WESTMORELAND COUNTY.					
Shaffer	Laurelville		None.			
	YORK COUNTY.					
Underwood	Carroll township	Wm. Letcher	6,720	Magnetite	No. 1 pig, boiler-, plate-, and sheet-iron.	Newport, Perry Co., and small lots.
Hanover	Near Hanover	Chickies Iron Co	6,323	Limonite	Foundery and mill	
Bell	Dillsburgh	Henry McCormick	4,480	Magnetite	Red-short	
Moulds	Pigeon Hills	Ashland Iron Co	5,600	Limonite	Foundery	All to Ashland.
Longenecher	Dillsburgh	G. A. Longenecher	4,480	Magnetite	No. 1 foundery	Wrightsville and Middletown.
Logan	Carroll township	McCormick & Co	None.	do	All kinds	Harrisburg.
McClure & Smyser	do	D. L. Jauss	8,960	do	Neutral foundery; red-short pig, nails, plates, merchant bar, Bessemer steel, and rails.	Harrisburg, Marietta, Middletown, and Northumberland.
Fritz	Spring Garden township.	Benson Hottutt	2,882	Limonite	Bar, plate, foundery, and neutral pig.	Donegal furnace, Marietta, Lancaster county.
Roth	Spring Grove	Henry J. Rahe	1,064	Specular	Anthracite pig	Benson and Catrill, Columbia, and Wrightsville Iron Co., Wrightsville.
Lichty	Washington township.	Amos Rupert	422	do	Neutral	Donegal furnace, Lancaster county; Vesta furnace, Lancaster county; Cameron furnace, Middletown, Dauphin county; Dock furnace, Dauphin county.
Menges	Jackson	George Menges	1,344	do	Foundery forge pig	Marietta, Donegal furnace, Wattses, and Wrightsville.

Directory of iron-ore mines—Continued.

PENNSYLVANIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	YORK CO.—cont'd.					
Codorus or Strickhouser.	North Codorus township.	Codorus Min. Co	8,329	Specular and magnetite.	Strong pig and foundery.	Pittsburgh, Reading, and vicinity, and Wrightsville.
Feigley	Near Logansville	Cordelia Iron Co	3,248	Limonite	Neutral foundery, mill pig, hardware, stove-plate, machine castings, and boiler- and ship-plate.	Cordelia, Lancaster county.
Springfield	Springfield township	Charles M. Nes	224	do	Foundery pig No. 1 and wrought.	Columbia and Marietta, Lancaster county.
Grove	Dillsburg	Shelby & Hoffer	1,008	Magnetite	Red-short for Bessemer.	Harrisburg and Marietta.
Miller	Jacob's mills	John Kaufman	3,390	Limonite	No. 1 foundery	Ashland Iron Co., Ashland.
J. and D. Bollinger	Iron ridge	Leesport Iron Co	2,800	do	do	Leesport.
Fuller	Carroll township	J. C. Fuller	560	Magnetite	Bessemer	Pine Grove, Boiling Springs, and parties on Susquehanna.
Keeny	Near Glen Rock	Watts, Tweils & Co., limited.	1,736	Limonite	Foundery, stove-plate, and light castings.	All for own use.
		E. B. Myers	442	do		
		Menges & Paull	131	Specular		
		Rahe & Martin	757	do		
		Emanuel Wolf	1,350	Limonite		
		A. L. Hursh	59	Magnetite		
		Shelby & Hoffer	279	do		
		L. B. Morganroth	130	do		
		Jauss & King	144	do		
		John Wynhoop	784	do		
		Henry Kraber	2,509	Specular		
		G. W. Sprenkle	170	Limonite		
		E. B. Sprenkle	156	Specular		

RHODE ISLAND.

	PROVIDENCE COUNTY.					
Cumberland Hill	Cumberland		None.	Magnetite		

SOUTH CAROLINA.

	UNION COUNTY.					
Magnetic Iron Co	Cherokee ford		None.	Specular		

TENNESSEE.

	BLOUNT COUNTY.					
Maryville	Maryville	Roane Iron Co	2,342	Limonite	Pig for steel	Rockwood furnace.
	BRADLEY COUNTY.					
Hinch	White Oak ridge	T. R. Hinch & Bro	2,818	Fossil	Foundery pig	Chattanooga and South Pittsburgh.
Hoskins' Hinch	Hinch	S. B. Lowe	7,000	do	do	Do.
Vaughn	McDonald	Jefferson Vaughn	113	do		Do.
	CARTER COUNTY.					
Taylor	Carter's furnace	Knoxville Car-Wheel Co.	1,635	Limonite	Car-wheel	All at furnace.
Lipps	do	do	224	do	Car-wheel pig	Maxwell furnace.
Hodge	Stony Creek valley	do	1,130	do	do	All at Carter and Maxwell's furnaces.
Honeycomb	Carter's furnace	do	1,120	do	do	
Liver Ore	do	do	336	do	do	Carter furnace.
	DICKSON COUNTY.					
Cumberland furnace	Cumberland furnace	J. P. Dromillard & Co.	7,938	Limonite		All to own furnace.
Worley	Worley furnace	Warner Bros	2,835	do	Strong mill	Do.
	HAMBLEN COUNTY.					
Hamblen	Witt's foundery	Roane Iron Co	5,600	Limonite	Open-hearth steel furnaces.	Own furnace.
	JAMES COUNTY.					
Sanders & Whiteside.	Near Ocltewah	J. P. Bond	7,030	Fossil	Foundery	Chattanooga Iron Co., S. B. Lowe, South Pittsburgh, for Southern States, C., I. and L. Co.

Directory of iron-ore mines—Continued.

TENNESSEE—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	JAMES CO.—cont'd.					
Tallant	Near Ooltewah	C. C. Vest	1,127	Fossil	Foundery pig	Chattanooga Iron Co. and Pittsburgh.
Lee	do	T. J. Lee	1,701	do		South Pittsburgh and Chattanooga.
White Oak Ridge	Ooltewah	J. S. Ragan	560	do		Do.
White Oak mountain	Near Ooltewah	J. A. Greene	2,817	do	do	South Pittsburgh, Chattanooga, and Knoxville.
	JOHNSON COUNTY.					
Keller	Dryrum	A. M. Dougherty & Co	1,112	Limonite		Forges in this county.
Little Mountain	Fourth Civ. Dist	Dan'l Slimp	112	do	No. 1 wrought and pig	
Washplace	Pandora	Wm. A. Morley	546	do	All kinds of pig and wrought.	All to own blacksmith shops.
Hodge	Roane's creek	Mr. Hodge	175	do	Bar, blooms, plow-points, and wagon-tires.	Forges.
Taylor	Dugger's ford	Taylor & Baker	400	do	Blooms and bar	
Tompkins	Little Doe	M. M. Wagner & Son	300	do	Bar	Forge.
Laurel Bloomery	Laurel bloomery	Fred. Slimp	90	do	Wagon-tires, horse-shoes, hoops, chains, wagon-bands, plates, hoes, mattocks, harrow-teeth, hammers, sledges, tongs, R. R. spikes, etc.	Abingdon, Va., and Bristol, Tenn.
Near and Far Mt	Walker forge	Geo. J. Walker	112	do	Foundery pig and bar	Neighborhood.
Gentry	Potter's forge	J. O. Potter & Son	202	do	Foundery pig, bar, and blooms.	Do.
Rhea	Near Rhea's forge	R. C. Rhea	None.	do	Hammered bar	Own forge.
Razor Rock on Gentry mountain.	Shoun's Cross-roads.	H. C. Donnelly	12	do	Hammered bar and pig	Home.
	LAWRENCE COUNTY.					
Napier	Napier furnace	Napier Iron Co	641	Limonite	Cold-blast car-wheels, wrought, boiler-heads, and plate.	All at furnace.
	MEIGS COUNTY.					
Red Cloud	Euchee	Hill & Tarwater	10,206	Fossil	Foundery, mill, and wrought.	Chattanooga and South Pittsburgh.
	PERRY COUNTY.					
Cedar Grove	Near Linden		None.	Limonite		
	RHEA COUNTY.					
Iron Hill	Iron Hill	Hill & Tarwater	13,608	Fossil	Foundery, mill, and wrought.	Do.
Enterprise	Lorraine	Helow Roberts	None.	do	Pig and bar	Do.
	ROANE COUNTY.					
Welcker's Ridge	Welcher's	J. D. Roberts	4,480	Fossil	Pig, stove, and castings	Rockwood and Chattanooga.
Hinckes	Eagle furnace	Jerry Gibson	3,136	do		Southern States C., I. and L. Co., South Pittsburgh, Vulcan works, Chattanooga and Roane I. Co.
Ironton	Kings Landing	Thos. Brown	7,433	do	Foundery pig and car-wheels.	Rockwood furnace.
	Webster	Oak Dale Iron Works.	None.		Foundery and mill	All to furnace.
		Rockwood, Nos. 1 and 2.	13,732	do		
Oak Dale Iron Works.		Watson & Ballou	800	do		
	STEWART COUNTY.					
Bear Spring	Cumberland Iron Works.	Cumberland Iron Works Co.	1,043	Limonite		
La Grange Iron Co	La Grange furnace	La Grange Iron Co	None.			

TEXAS.

	MARION COUNTY.					
		Kelly furnace	3,600	Limonite		

UTAH TERRITORY (see p. 227).

	BEAVER COUNTY.					
Cave	Bradshaw district	Frisco Min. and Smelting Co.	1,833	Limonite	Flux	Own furnace.

Directory of iron-ore mines—Continued.

VERMONT.

Name of mine.	Location.	Name of operation.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	FRANKLIN COUNTY.					
Brainerd	Fairfield	A. O. Brainerd	560	Specular	Steel	Saint Albans.
	WINDSOR AND RUTLAND COUNTIES.					
White River Iron Co.	Pittsfield and Bethel		None.	Magnetite		

VIRGINIA.

	ALBEMARLE COUNTY.					
		Wm. Betts	53	Limonite		
	ALLEGHANY COUNTY.					
Moyer	McDowell's switch	S. L. McDowell and L. T. Dickey.	896	Limonite	Mill and foundery	Quinnimont furnace, W. Va.; Lowmoor and Buffalo Gap furnaces, Va.
Peters mountain	Callaghan's	Lewis & Gay	112	do	Foundery and mill	Pennsylvania and Virginia Iron and Coal Co., Quinnimont, W. Va.
Lowmoor	Lowmoor	Lowmoor Iron Co	26,880	do	do	Ohio river markets.
Australia	Long Dale	Long Dale Iron Co	19,666	do	Foundery and forge	Own furnace.
Stacks	Dickson's switch	W. W. Sadler	4,480	do	Mill	Lowmoor Iron Co. and Pennsylvania and Virginia Iron and Coal Co.
Excelsior	Kean farm	Timoleon G. Trice	560	do	Car-wheel, mill, and foundery.	Furnaces on C. and O. R. R. and Ohio river.
Huddleston	East slope of Peters mountain.	A. E. Huddleston	448	do		Quinnimont, W. Va., and on Ohio river.
Clifton forge	Clifton forge	Henry Body	8,064	do	Mixture	Quinnimont, W. Va.
	AMHERST COUNTY.					
Riversville	Riversville	Commonwealth M'f'g Co.	3,360	Specular	Bessemer pig	Bessemer Steel Co., east of Alleghanies.
Stapleton	Stapleton mills	do	6,720	do	Bessemer pig, foundery, car-wheels, spiegel-eisen, and ferro-manganese.	Pittsburgh and Bessemer Steel Works, east of Pittsburgh.
	Mundy est	Lynchburg Iron, Steel, and Mining Co.	560	Limonite	Common foundery	Baltimore, New York.
	AUGUSTA COUNTY.					
Ferrol	Ferrol	Pennsylvania and Virginia Iron and C. Co.	16,036	Limonite	Foundery, mill, and machinery.	Ohio R. R., Pittsburgh furnaces, and Quinnimont furnace, W. Va.
Davidia	Rockfish Gap	Davidia I. and Steel Co	616	do	Neutral, for steel	Buffalo Gap furnace.
		Eureka Mining Co	66	do		
		H. G. Brooks	44	do		
	BEDFORD COUNTY.					
		Bedford Iron Mining and Manuf'g Co.	500	Limonite		
	BOTETOURT COUNTY					
Arcadia	Buchanan	Arcadia Iron Works.	28,000	Hematite		
Callie furnace	Callie furnace	Hillman, Cook & Co	225	Limonite	Foundery, mill, and bessemer.	Quinnimont.
	CAMPBELL COUNTY.					
Otter river	Otter River	Harry G. Blackwell	84	Magnetite	Bessemer pig	Pennsylvania.
		Lynchburg I. and S. Co.	224	Limonite		
	LOUISA COUNTY.					
Victoria	Victoria furnace	Ira F. Jordan & Co	None.			
		T. S. Leaks	14	Limonite		
	NELSON COUNTY.					
Greenway	North Greenway	Commonwealth M. Co.	3,360	Specular	Bessemer pig	Bessemer Steel Co., east of Pittsburgh.
	PITTSYLVANIA COUNTY.					
		R. F. Mason	11,292	Magnetite		
		Edward Samuels & Co.	363	do		
		P. and R. C. and I. Co	71	do		
	ROCKBRIDGE COUNTY.					
Buena Vista	Green Forest	Buena Vista Iron Mine	None.	Limonite	Car-wheels	Own furnace.
	ROCKINGHAM COUNTY.					
Raines & Weaver	Mt. Vernon I. Works	Harnsberger, Hawkins & Co.	22,400	Limonite	Boiler	Abbott Iron Company.
Fox Mountain	Furnace No. 2	William Milnes, jr	8,960	do	Charcoal pig, boiler-plate, and flange.	

Directory of iron-ore mines—Continued.

VIRGINIA—Continued.

Name of mine.	Location.	Name of operator.	Product (tons of 2,000 pounds).	Kind.	Uses.	Where used.
	SHENANDOAH COUNTY.					
Old & Hollow	Liberty furnace	Wissler, Armstrong & Stone.	5,040	Limonite	Car-wheels, boiler-plate, rivets, wire, malleable castings, and hammered iron.	Own, Liberty, and Columbia furnaces.
3-mile and 5-mile	Columbia furnace	John Wissler & Son	2,800	do	Cold-blast charcoal, car-wheel.	
		N. Stephens	16	do		
	WYTHE COUNTY.					
Foster	Pierce furnace	New River Iron and Manufacturing Co.	336	Limonite	All kinds	
King & Johnson	Barren Spring	J. W. McGavock & Co.	2,240	do	Pig, car-wheels, and bar.	Own furnace.
Parter & Black Ore	Raven Cliff and Beverly furnace.	Crockett & Co	3,920	do	Cold-blast charcoal, car-wheel pig, horseshoes, tires, boiler-plates, etc.	
Carter	Cedar Run furnace	Graham & Robinson	1,120	do	Car-wheel pig, ordnance, and wire, tires, bars, horseshoes, etc.	Do.
Noble	Browne Hill	New River Mineral Co.	2,800	do	Cold-blast charcoal for car-wheels.	
Gray Eagle	Gray Eagle furnace.		None.	do	Car-wheels	

WEST VIRGINIA.

	BRAXTON COUNTY.					
Elk River Iron Co		Elk River Iron Co	2,500	Carbonate		Own furnace.
	HAMPSHIRE COUNTY.					
Postley, Open Cut, and Minnesota.		Bloomery Furnace Co.	7,000	Fossil		Bloomery furnace.
	HARDY COUNTY.					
North Mountain and Half Moon.	Capon Iron Works	Bunting & Keesler	448	do	Car-wheels and boiler-plate.	Lobdell Car-Wheel Co., Wilmington, Del.
	KANAWHA COUNTY.					
		From Kanawha	680	Carbonate		
		Jesse S. Savage	165	do		
	MORGAN COUNTY.					
Mendenhall	Sir John's Run	A. B. Desaules	2,800	Limonite		Dunbar Iron Works, Pa.
	PRESTON COUNTY.					
Kinger & Fitchenell	Pleasant township	S. B. Patterson	225	do	Cold-blast charcoal	Own use.
Irondale furnace	Irondale	Felix Nemegyer	29,120	Carbonate	Cold-short pig, merchant, plates, and rails.	Owen furnace.
Gladesville	Gladesville	Gladesville Iron Co	4,480	Limonite	Charcoal pig	Do.
	TAYLOR COUNTY.					
Rossett	Irontown	C. S. Hurd	13,798	Carbonate	Pig	All to Waldorf furnace, Irontown.

WISCONSIN.

	DODGE COUNTY.					
Iron Ridge	Iron ridge	North Chicago rolling-mill and others.	39,200	Fossil	Cold-short	Chicago, Milwaukee, and own furnace.
Mayville	Iron mountain	Northwestern Iron Co	None.		do	
	MARINETTE COUNTY.					
Florence	Florence	Menominee Mining Co.	None.	Specular	Pig	Chicago, Milwaukee, and Ohio furnaces.
	SAUK COUNTY.					
Sauk	Ironton	M. K. Doyan	2,240	Limonite	Foundery	

WYOMING TERRITORY.

	CARBON COUNTY.					
Rawlins	Rawlins		None.	Hematite	Flux and paint	Mostly to Salt Lake City.

Colorado and Utah iron not used for manufacture of iron, and therefore not counted in totals.

Directory of copper mines.

State or territory.	County.	Locality.	Name of mine.	Name of operator.	Ingots
					Pounds.
Alaska					3,933
Arizona	Apache		Longfellow Copper	Longfellow Cu. Mining Co	3,112,500
Do	do		Metcalf		None.
Do	do		Globe		None.
Do	do	8 miles northwest of Clifton	Coronado Group	Longfellow Mining Co	71,250
Do	Pima	22 miles southeast of Charleston	Copper Queen	Cu. Queen Mining and Smelting Co	None.
Do	do		Copper King	do	None.
Do	do		Ajo Copper Mines		None.
California	Amador	2½ miles east of Ioning	Newton	Newton Copper Mining Co	720,000
Colorado	Arapahoe				980
Do	Jefferson				598
Georgia	Rockdale				922
Maine	Hancock	Blue Hill	Young Hecla	Young Hecla Cu. Mining Co	None.
Do	do	do	Atlantic Copper Mining Co	Atlantic Copper Mining Co	None.
Do	do	West Brooksville	Tapley	E. B. Smith & Co	None.
Do	do	Blue Hill	Granger Copper Mining Co	Granger Copper Mining Co	None.
Do	do	Winter Port	Gardner Mountain Copper Min. Co	Gardner Mountain Copper Mining Co	None.
Do	do	Blue Hill	Excelsior	Excelsior Co	None.
Do	do	do	Blue Hill Central	Blue Hill Central Copper Mining Co	None.
Do	do	do	Douglass Copper Mining Co	Douglass Copper Mining Co	22,500
Do	do	do	Blue Hill Copper Min. and Sm'l'g Co	Blue Hill Copper Mining Co	20,000
Do	do	do	Twin Lead Copper Mining Co	Twin Lead Copper Mining Co	60,000
Idaho	Lemhi				150,000
Maryland	Baltimore				1,275
Do	Carroll	7 miles from Finksburgh	Mineral Hill	Mineral Mill Mining Co	164,640
Do	Frederick		Liberty	Maryland Copper Mining Co	None.
Michigan	Houghton	Atlantic	Atlantic	Atlantic Mining Co	2,586,000
Do	do	Hancock	Franklin	Franklin Co	2,829,585
Do	do	do	Quincy Mining Co	Quincy Mining Co	2,784,821
Do	do	do	Pewabic	Pewabic Co	336,475
Do	do	Calumet township	Osceola	Osceola Consolidated Mining Co	3,231,581
Do	do	Calumet	Calumet and Hecla	Calumet and Hecla Mining Co	28,620,750
Do	Isle Royale	Minong Mine Landing	Minong	Minong Mining Co	80,000
Do	Keweenaw	Phœnix	Phœnix Copper Co	Stock Co	483,431
Do	do	Delaware	Delaware	Delaware Copper Co	143,900
Do	do	Allouez	Allouez	Allouez Tribute Co	1,337,897
Do	do	Central Mine	Central Mine	Central Mining Co	1,799,495
Do	Ontonagon	Greenland	Ridge	Ridge Copper Co	300,600
Do	do	do	Mass Mining Co	Mass Mining Co	484,000
Do	do		Flint Steel River Copper Co	Flint Steel River Cu. Co	34,992
Do	do		Evergreen		711,480
Do	do		Ogima		27,270
Do	do		Adventure		25,520
Do	do		Hilton		1,545
Do	do		Astec		11,520
Do	do		National		None.
Missouri	Sainte Genevieve	10 miles southwest of Saint Genevieve.	Cornwall	O. D. Harris	191,273
Do	do	8 miles west of Sainte Genevieve	Swansea	John and Leon Bogg and Leon Jackerst	31,364
Do	do	do	Herzog	Jakers & Fegga	8,080
Montana			Hetty Harvey and Mountain	New York and Montana Copper Co	306,112
Do	do				7,650
Do	do				898,738
Nevada	White Pine	Robinson district	Fairview		41,600
Do	do	do	IXL		31,190
Do	do	do	Lone Star, Brooks, Argenta, Last Chance, Southern Cross, and Watson.		47,110
Do	do	do	Star of the West and Blue Bird		14,820
New Hampshire	Grafton	Littleton	White Mountain	Dole Brothers	None.
Do	do	Lyman	Hairland Copper M. Co	Hairland Copper Mining Co	None.
Do	do	do	Paddock	J. H. Paddock	34,050
New Mexico					4,055
North Carolina	Ashe	Ore Knob	Ore Knob Copper Co	Ore Knob Copper Co	1,600,000
Do	do	Gap creek	Copper Knob	Copper Knob Mining Co	40,000
Pennsylvania	Montgomery	Pottstown	Gilbert	Samuel Milligan	40,400
Do	do				38,550
Do	Lancaster				135,720
Tennessee	Polk	Ducktown	Old Tennessee	McLeod & Co	153,880
Texas					5,084
Vermont	Orange	Ely	Vermont Copper Mining Co	Vermont Copper Mining Co	2,647,894
Virginia	Loudoun				678
Wisconsin	Iowa	Mineral Point	Old Beach Lead	Wm. T. Henry	18,087

Directory of lead and zinc mines.

State or territory.	County.	Locality.	Name of mine.	Name of operator.	Lead.	Zinc.
					Pounds	*Pounds.*
Illinois	Jo Daviess	East Galena	Ortscheid	Ortscheid, Melville, and Kuckman	119,000	
Do	do	do	Spratt	Spratt & Co	500,000	
Do	do	Council Hill	W. Oxman & Son	W. Oxman & Son	20,000	
Do	do	Rice township	Kipp	Keiser, Myer, Beasman, and Kipp	54,000	
Do	do	Kamphouse Hollow	Kamphouse	Burrichter & Harris	240,230	
Do	do	Near Buncombe	Manuell & Raine	Manuell & Raine	10,000	
Do	do	Ren Town	Marsden	Aug. Pein	600,000	6,000,000
Iowa	Clayton	Guttenberg	Goodrich		3,000	
Do	Dubuque	Dubuque township	Owens	James Rooney and Jacob Collins	None.	None.
Do	do	do	Sink Hole Crevice	Leathers, Horner, and McLane	1,300	
Do	do	do		Spensley and A. Cop	5,000	
Do	do	Maquoketa	Baker Range	Spensley & Works	4,000	
Do	do	Dubuque	Bowen	Dumgan & McBride	90,600	
Do	do	do	Moser	F. E. Moser	600,000	
Do	do	Centre Grove	Pike's Peak	R. O. Anderson	10,000	
Do	do	Julian township	Stewart, Cobb & Eighnig	Stewart, Cobb & Eighnig	None.	None.
Do	do	West Dubuque	B. Bassler	B. Bassler	None.	None.
Do	do	Dubuque	Keneday	Tingel Bros	3,600	
Do	do	do	Dubuque	John Goldthorp	50,000	
Do	do		Burton	Fred Hass	2,200	
Do	do	Maquoketa	Longworthy Range	John Spensley	None.	None.
Kansas	Cherokee	Empire City	Empire Mining Co	Picher L. & Z. Co., and W. N. Barrow	160,000	897,391
Do	do	Near Galena	South Side Town Mining Co	South Side Town Mining Co	619,000	640,000
Do	do	do	Galena Mining and Smelting Co.	Galena Mining and Smelting Co	3,248,167	150,000
Do	do	One-half mile east of Galena	Folmer Tract	Williamson, Grove, Stone & Co	280,000	64,000
Do	do	Galena	Rosenthal & Teetle	Rosenthal & Teetle	575,900	136,000
Do	do	Empire City	West Joplin Lead and Zinc Co	W. Joplin L. & Z. Co., and S. Cheney	910,769	1,300,000
Do	do	One-half mile south of Galena	Baker's Diggings	Connor, McClellan, and S. L. Cheney	2,500,000	1,300,000
Do	do	One-half mile west of Galena	Bloomington	Galena Crusher Co	52,000	56,800
Do	do	Empire City	Empire City Town Co	Empire City Town Co	233,548	200,000
Do	do	Galena	Cornwall Mining and S. Co	John M. Ritter, Tamblyn, White, and others.	164,400	16,000
Do	do	Bonanza	Bonanza	Bonanza Mining and Smelting Co	820,240	930,000
Do	do	Three-fourths mile east of Galena	Byers, Murphy & Connor	Wm. Byers, Patrick Murphy, and Thos. Connor.	218,624	2,400
Maryland	Frederick	Unionville	Unionville	Wm. A. Ingham and Gen. Wm. Lilly		1,344,000
Missouri	Christian	Swan Creek	Swan Creek	W. J. Roberts, H. Burkhardt, and J. R. Patton.	604,000	
Do	Cole	Three miles north of Elston	Durham	J. A. Elston	700	
Do	do	Two and one-half miles west of Decatur.	Van Sandt	Geo. Van. Sandt	42,000	
Do	Dade	Corry	Corry	Dade County Mining and Smelting Co.	67,200	82,000
Do	do	Four miles south of Pemberton	Overall	do		26,000
Do	do	Pemberton	Pemberton	Pemberton heirs		60,000
Do	Franklin	5 miles southeast of Saint Clair	Mo. M. and S. Co., lim	Mo. M. and S. Co., lim	140,000	
Do	do	1 mile east of Saint Clair	Northumberland	J. C. Richardson, W. C. Ford, W. F. Reder, and F. H. Carpenter.	21,000	
Do	Greene	Ash Grove and Pickerel	Swinney, Wilson & Co	Swinney, Wilson & Co	70,000	2,000
Do	do	Brookline	Oliver	J. B. Sherman	31,000	
Do	do	Ash Grove	Ash Grove	Walker & Perriman	810,000	
Do	Jasper	Joplin	Granby	Granby M. and S. Co	2,080,265	500,400
Do	do	Joplin and vicinity	Lone Elm M. and S. Co	Maffet & Sergeant	3,180,000	
Do	do	6 miles southeast of Joplin	Burch diggings	Lone Elm M. and S. Co	200,000	
Do	do	Joplin	Lone Elm	do	1,343,000	
Do	do	do	McKee	do	8,000	
Do	do	do	Paxton	do	1,343,000	
Do	do	do	Picher L. and Z. Co	Picher L. and Z. Co	2,459,228	1,351,932
Do	do	2 miles southeast of Joplin	Thousand Acres	Picher L. and Z. Co., and Granby M. and S. Co.	2,810	2,184
Do	do	Joplin	Picher Field	Picher L. and Z. Co	1,441,148	1,351,932
Do	do	2 miles northeast of Joplin	Turkey Creek	do	12,226	21,120
Do	do	Joplin	W. Joplin L. and Z. Co	W. Joplin L. and Z. Co		
Do	do	do	Joplin diggings	do		
Do	do	5 miles west of Joplin	Steven's diggings	do		
Do	do	1½ mile southwest of Joplin	Carney diggings	do	1,000,000	2,000,000
Do	do	5 miles northwest of Joplin	Sherwood diggings	do		
Do	do	2½ miles northwest of Joplin	Leadville diggings	W. Joplin L. and Z. Co., and C. H. Brewster.		
Do	do	Carterville	Carterville M. and S. Co	Daugherty & Wilson	825,506	5,082,592
Do	do	Webb City	Center Cr. M. and S. Co	Center Cr. M. and S. Co	427,973	2,561,609
Do	do	South Carterville	Webb City M. and S. Co	Webb City M. and S. Co	2,100	600
Do	do	Webb City	McCorkle & Aylor	McCorkle & Ayler	134,014	74,408
Do	do	do	Walker & Elliott	Walker & Elliott	210,000	16,000

Directory of lead and zinc mines—Continued.

State or territory.	County.	Locality.	Name of mine.	Name of operator.	Lead.	Zinc.
					Pounds.	*Pounds.*
Missouri	Jasper	Oronogo	Granby M. and S. Co	Granby M. and S. Co	389, 533	241, 446
Do	do	Belville City	Belville	Belville L. and Z. Co	340	910, 400
Do	do	2½ miles southwest of Carthage.	Pleasant Valley M. and S. Co	Pleasant Valley M. and S. Co	14, 160	484, 178
Do	do	4 miles west of Joplin	Neutral of Stevens Diggings	John Shorten and J. J. Stearns	2, 800	48, 000
Do	do	Joplin	Porter and Dorsey Tract	Porter and Dorsey	224, 000	192, 000
Do	do	do	North Joplin M. and S. Co	North Joplin M. and S. Co	75, 400	20, 000
Do	do	1 mile north of Joplin	Clauser Tract	New York and Joplin M. and S. Co	532, 895	15, 066
Do	do	Joplin	Joplin M. and S. Co	Joplin M. and S. Co	679, 714	112, 870
Do	Jefferson	Frumet	Frumet	North Saint Louis and German Savings Bank.	35, 000	
Do	do	Old Ditch	Hart Lands	N. M. Christian	5, 000	
Do	do	Frumet	Sixteenth Section	S. Myer and Wyman	33, 000	
Do	do	Old Ditch	Vallé Diggings	J. M. Douglas	3, 250	
Do	Madison	Einstine Silver Mine	Einstine Silver Mine	Silver Mt. Min. Co	32, 639	
Do	do	Mine LaMotte	La Motte	Rowland Hazard	3, 965, 760	
Do	Moniteau	8 miles northeast of California	Boyde English	B. English and Kinworthy	4, 200	
Do	Morgan	8 miles southwest of Versailles	Potter	Silvie & Rowe	38, 500	
Do	do	10 miles north of Line Creek	Johnson	J. Johnson	15, 400	
Do	do	12 miles southeast of Versailles	Indian Creek		7, 000	
Do	do	20 miles northwest of Versailles	Berry	Wm. Berry	29, 400	
Do	Newton	Granby	Granby	Granby M. and S. Co	1, 804, 950	7, 644, 000
Do	St. François	Bonne Terre	St. Joe Lead Mine	Saint Joe Lead Co	8, 465, 680	
Do	do	do	Desloge	Desloge Lead Co	4, 000, 000	
Do	do	Vallé Mines	Vallé Mines	Vallé Mining Co	204, 115	1, 694, 475
Do	Washington	Mineral Point	Boas	F. M. Boas	20, 552	
Do	do	4 miles N. of Potosi	Cole Land	Capt. Geo. B. Cole	42, 000	
Do	do	Richwoods	Burnham Land	C. B. Burnham	63, 165	
Do	do	Potosi	Dean Tract	Heirs of John Dean and S. Richeson	357, 700	517, 202
Do	do	Near Hopewell	Evans	Robert H. Evans	27, 829	
Do	do	Concord township	Perrine	F. Blackman	7, 000	35, 000
Do	do	Kingston Furnace	Saint Louis Lead Mining Co	Saint Louis Lead Mining Co	23, 927	
Do	do	3 miles NW. of Potosi	Perry	J. P. & R. M. Bugg	370, 893	
Do	do	Old mines and vicinity	Thos. S. White	T. S. White	112, 554	
Do	do	Mineral Point	Mesplay	V. B. Mesplay	15, 000	
Do	do	Richwoods	Moran Claim	J. W. Wilder	97, 140	
Do	do	1½ miles from Mineral Point	Ohio Lead Co	Ohio Lead Co	87, 000	18, 000
Do	do	Old Mines	Old Mines Lead Co	Old Mines Lead Co	195, 844	
Do	do	Palmer and vicinity	Palmer Lead Co	Palmer Lead Co	310, 113	
Do	Wright	7 miles from Hartville	McMullen & Berry	John B. Sherman		240, 000
Do	do	10 miles from Hartville	Davis	—— Davis	72, 000	
New Jersey	Sussex	Ogdensburg	Franklinite and Zinc	Manganese Iron Ore Co		2, 241, 000
Do	do	Franklin Furnace	Mine Hill Zinc and Sterling Hill	N. J. Zinc Co		11, 070, 514
Do	do	do	Trotter's Mine	Chas. W. Trotter		*a*$12, 937
Do	do	Ogdensburgh	Passaic Zinc Mine	Passaic Zinc Co		*a*$62, 496
Do	do	Franklin	Taylor	Moses Taylor		*a*$65, 035
New York	Ulster	Ellenville	Wawarsing	W. W. Evans	None.	None.
Do	do	One-quarter mile S. of Ellenville	Ellenville		None.	None.
Do	do	Shawangunk mountains	Erie		None.	None.
Do	do	Red Bridge			None.	None.
Pennsylvania	Lehigh	Friedensville	Correll	F. Osgood & Co		3, 000, 000
Do	do	do	Lehigh Zinc Mine	Lehigh Zinc Co		1, 559, 746
Tennessee	Claiborne	Straight Creek	Richberg	Jno. Richberg		428, 571
Do	Jefferson	Leadvale	Leadvale	A. H. Gregg	50, 000	*a*$250
Do	do	Mossy Creek	Church Lot	J. B. Barrett		*a*$895
Do	Knox	McMillan	Ten Mile	Ill. and Tennessee M. and S. Works		*a*$2, 000
Do	McMinn	Near Riceville	Lead and Silver	Hamilton Pearce	None.	None.
Do	Union	New Prospect	Union Co. Zinc Mine	Manning & Squier		*a*$10, 000
Virginia	Wythe	Near Barren Spring Furnace	Falling Cliff Zinc	D. S. Forney	None.	None.
Do	do	Austinville	Wythe Lead and Zinc	Wythe Lead and Zinc Mine Co	866, 868	
Do	do	Near Barren Springs	Bertha Zinc Mine	Bertha Zinc Co		288, 888
Wisconsin	Grant	Platteville	Boots Range	John M. Gardner & Bros	30, 000	
Do	do	do	Murphy & Hennings	Murphy & Hennings	300, 000	
Do	do	British Hollow		Honeycomb & Basing	2, 000	
Do	do	Platteville	Phenix & Strong	Phenix & Strong	6, 000	
Do	do	do		Ben. Cane & Co	6, 000	60, 000
Do	do	Bectown		M. Walker and Wm. C Moody	11, 000	
Do	do	Lindens Ground	A. Sans & Co	Adam Sans and H. Voss	30, 000	
Do	do	Platteville	Lane Range		(*a*)	(*a*)
Do	do	Muscalange	Hutchcroft & Thomas		None.	None.
Do	do	Platteville	Messersmith	Messersmith Bros	None.	None.

a Value.

Directory of lead and zinc mines—Continued.

State or territory.	County.	Locality.	Name of mine.	Name of operator.	Lead.	Zinc.
					Pounds.	*Pounds.*
Wisconsin	Grant	Platteville	Messersmith & Rowe		None.	None.
Do	do	do		Messersmith & Griffin	None.	None.
Do	do	do	Waters Range	Wm. Waters	4,000	
Do	do	do	Bellmire Range	Fred. and Dennis Bellmire and Henry Sanders.	4,630	
Do	do	Platterville	Hammons & Davison	Hammons, Davison & Jones	15,000	
Do	do	Potosi		Henry Warnenhurs & Co	8,000	
Do	do	Platterville	Teller		20,000	
Do	do	Potosi	Maynes	Maynes & Kern	10,000	
Do	do	Platteville	Platteville	Murphy & Henning	400,000	100,000
Do	do	do	City Mine		21,000	
Do	do	Beetown	Beetown	Ross, Gundry, Foay & Henry		240,000
Do	do	Big Patch	Todd Range		10,000	
Do	do	Platteville	Lane Range	H. C. Lane & Carlile	(a)	(a)
Do	do	do	Riley	John & Jas. Riley	8,000	
Do	do	do	Dixon	W. Williams	10,000	
Do	do	Hazel Green	Gens	Conrad Gens	130,000	
Do	do	Toadville				40,000
Do	do	Beetown	Mass, Rogers & Co		25,000	
Do	do	Platteville	Connelly & Burns	Howe, Blader & Co	32,000	
Do	do	Beetown	Muscalunger	O. C. Hathaway	56,790	
Do	do	do	Burns Bros. & Rogers	T. Burns	100,000	
Do	do	Hazel Green	Meaker & Hardy	J. M. Chandler	None.	None.
Do	do	Menomonee	Hoffman & Tultz	Hoffman & Tultz	None.	None.
Do	do	Potosi	McGuire	Morris & McGuire	24,000	
Do	do	do	Stuar	A. Geller, Stuar & Co	40,000	
Do	do	do	Gerhard	Gerhard & Co	1,000	
Do	do	do	Sand Range	Zeigg & Raiser	6,000	
Do	do	do	Rairdon	S. & W. Wilmarth & Co	4,000	
Do	do	Muscalange			20,000	
Do	do	British Hollow	Syphon Hollow		None.	None
Do	do	Beetown	Lead	G. Ewing	None.	None.
Do	Iowa	Mifflin	J. B. Huse & Co		20,000	
Do	do	do	Mifflin Min. Co		10,000	1,000,000
Do	do	do	Black Jack		6,000	300,000
Do	do	Linden	Diamond Grove	David Brown	12,000	360,000
Do	do	Mifflin	Black Jack		5,000	16,000
Do	do	Mineral Point	Hutchison & Co	John Hutchison	50,000	400,000
Do	do	Mineral Point	Riddle	Riddle & Paynter	1,000	90,000
Do	do	do	Mineral Point Hill	James Dunn		80,000
Do	do	do			3,000	130,000
Do	do	do	Poverty Ridge	Sleep & Vivian	1,000	80,000
Do	do	do	Terrill Lot	John Collins & Co	4,000	40,000
Do	do	do	Irish Diggings	William Coad & Co	2,000	14,000
Do	do	do	Perry, Boyn & Spenseley	Perry, Boyn, Spenseley & Arker	10,000	60,000
Do	do	Dodgeville		D. George & Co	50,000	
Do	do	do			10,120	
Do	do	do	Dodgeville			150,000
Do	do	Highland	Ohlerking	Charles Ohlerking	8,000	
Do	do	do	Flynn, Woodward & Co	Michael Flynn	50,000	300,000
Do	do	do			25,000	100,000
Do	do	do	Pechan & Zeman	Joseph Pechan		50,000
Do	do	Ridgeway	Union	Bennett, Munsly, Paull & Morris	100,000	
Do	do	do		Thomas Paull & Co	25,000	
Do	do	do	Ridgeway	Munday, Moon & Co	40,000	
Do	do	Dodgeville			30,000	
Do	do	Near Dodgeville	Holyhead	Thomas Williams		10,000
Do	do	"Survey" Dodgeville	Van Meter	Frank Vivian, Elisha Turre, John Simons, and Joseph Edwards.	120,000	
Do	do	Welch Hollow		Jones, Faraghar & Co	60,000	100,000
Do	do	Linden	Thomas & Falls	Thomas, Falls & E. George	4,000	500,000
Do	do	Dodgeville	Sobey & Co	J. Sobey, G. F., J. D. & J. Darcy	100,000	1,400,000
Do	do	Linden	Blue Jacket		800	20,000
Do	do	Welch Hollow	Williams	Evan Williams	20,000	130,000
Do	do	Dodgeville		Thomas Parry	6,000	
Do	do	Linden	Faul	Henry Faul	20,000	150,000
Do	do	do	Morrison	David Morrison	10,000	80,000
Do	do	do	Lamblin	Thomas Lamblin	8,000	150,000
Do	do	do	Glanville	Glanville Bros	50,000	150,000
Do	do	do	Linden	Ross & Henry	100,000	2,080,000

a Not returned.

Directory of lead and zinc mines—Continued.

State or territory.	County.	Locality.	Name of mine.	Name of operator.	Lead.	Zinc.
					Pounds.	*Pounds.*
Wisconsin	La Fayette	Argyle	Mudd Branch	John Alderson	10,000	
Do	do	do	Mattas	William Knewstubb	10,000	
Do	do	Belmont	E. Thomas & Co	E. Thomas & Co	200,000	
Do	do	Benton	J. McMunn & McGuire	J. McMunn & McGuire	80,000	
Do	do	do	Williams & Alexander	Williams & Alexander	4,800	30,000
Do	do	Buncombe	Dry Bone	Henry Carpenter & Co	10,000	12,000
Do	do	Elk Grove	Coats & Barker	Coats, Barker & Stevens	25,000	
Do	do	Fayette	Leafborough	William Leafborough	72,000	
Do	do	Meeker's Grove	Dixon & Co	Dixon & Co	20,000	
Do	do	Shullsburgh	Excelsior	Samuel Rickert	528,168	
Do	do	Yellow Stone		James H. Campton	2,000	
Do	do	Elk Grove	Rablin	Goodman & Webster	None.	None.
Do	do	Meeker's Grove	Kitto & Co	Kitto & Co	6,000	100,000
Do	do	Shullsburgh	Elevator	Weatherby & Beebe	146,245	
Do	do	Meeker's Grove	Shirwin & Koner	Shirwin & Koner		160,060
Do	do	Shullsburgh	Dry Bone	William Deppe	4,000	12,000
Do	do	Meeker's Grove	Kasting & Hyns	Kasting & Hyns	3,000	200,000
Do	do	do	Hynes & Co	Hynes & Co		50,000
Do	do	do	Winn & Co	Winn & Co	4,000	100,000
Do	do	Near Hazel Green	Dry Bone	Wallace, Nash & Co	30,000	60,000
Do	do	Shullsburgh	Fraiser & Co	Fraiser & Co	5,000	

Directory of Smelting and Reduction Works.

State or territory.	County.	Locality.	Name of company.	Name of operator.	Production.	Amount.
Illinois	Cook	Chicago	Horn Silver Mining Co	Horn Silver Mining Co	Lead ... pounds	5,242,263
					Silver ... ounces	338,744
					Gold ... dollars	786
Do	Jo Daviess	East Galena	Galena Furnace	Richard Bowden	Lead ... pounds	278,894
Do	do	Sand Prairie	Stevens Lead Furnace	T. G. Stevens	do ... do	114,228
Do	do	Elizabeth	Green's Furnace	H. Green	do ... do	84,000
Do	do	Galena	Hughlett's Furnace	Thomas B. Hughlett	do ... do	838,225
Do	do	Sinsinawa	Lead Furnace	R. M. & W. Spensdey	do ... do	48,750
Do	La Salle	Peru	Illinois Zinc Co	(Stock Co.) A. Means, mgr	do ... do	476,780
					Slag lead ... do	80,000
					Spelter ... do	8,286,264
Do	do	La Salle	Kinsman Zinc Co	Kinsman Zinc Co	do ... do	792,000
Do	do	do	Matthewson & Higbee Zinc Co	Matthewson & Higbee Zinc Co	do ... do	12,016,794
Do	Madison	Collinsville	Lumaghi Zinc Works	Octavus Lumaghi	do ... do	711,980
Iowa	Dubuque	Centre Grove	Brunshill's Furnace	David brunshill	Lead ... do	210,000
Do	do	Asbury district	Simpson's Furnace	N. Simpson	do ... do	471,168
Do	do	Rock Dale	Furnace	William G. Watters	do ... do	713,656
Kansas	Cherokee	Galena	Picher Lead and Zinc Co	Picher Lead and Zinc Co	do ... do	462,948
Do	do	Weir City	Chicago Zinc and Min. Co	J. H. C. Gross	Spelter ... do	1,873,703
Do	do	Galena	South Side Min. and Mfg. Co	Stone, Grove & Price	Lead ... do	2,460,551
Do	do	do	Galena M. and S. Co	Galena M. and S. Co	do ... do	3,442,052
Do	Crawford	Pittsburgh	Lanyon & Co	Robert Lanyon	Spelter ... do	3,029,250
Maryland	Baltimore	Baltimore		Pope, Cole & Co	Copper ... do	179,051
Massachusetts	Bristol	Taunton	Crocker Bros.' Works	Crocker Bros		
Do	Suffolk	Boston	Revere Copper Works	Revere Copper Co		
Michigan	Wayne	Detroit	Detroit and Lake Superior Cu. Co.	(Stock Co.) J. R. Grout, agent	Copper ... pounds	44,642,675
Missouri	Cole	Decatur	Decatur Furnace	Lesseabard & Steffens	Lead ... do	42,000
Do	do	Russellville	Van Zandt's Lead Furnace	George Van Zandt	do ... do	32,160
Do	Franklin	Saint Clair	Nortumberland Lead Co	W. C. Ford	do ... do	900,000
Do	Greene	Ash Grove	Walker's Lead Furnace	Ralph Walker	do ... do	952,000
Do	Jasper	Joplin	Granby Furnace	Granby Mining and Smelting Co		
Do	do	do	Joplin	Joplin Mining and Smelting Co	Lead ... pounds	247,024
					Slag ... do	67,150
Do	do	do	Lone Elm Mining and Smelting Co.	Lone Elm Mining and Smelting Co.	Lead ... do	17,055,238
Do	do	do	W. Joplin Lead and Zinc Co	W. Joplin Lead and Zinc Co	do ... do	4,048,780
Do	do	do	Picher Lead and Zinc Co	Picher Lead and Zinc Co	do ... do	4,441,796
					Slag ... do	985,005
					Carbonate lead ... do	23,911
Do	Jefferson	Antonia	Lerger's Lead Furnace	Jos. Lerger	Lead ... do	34,323
					Slag ... do	18,000
Do	do	Vallé's Mines	Vallé's Mines	Rozier & F. Le Vallé	Lead ... do	272,605
Do	Madison	Mine La Motte	Miné La Motte Smelting Works	R. Hazard	do ... do	3,965,760
					Nickel matte ... do	38,291

Directory of smelting and reduction works—Continued.

State or territory.	County.	Locality.	Name of company.	Name of operator.	Production.	Amount.
Missouri	Morgan	Rock Ford	Star Furnace	G. P. Clark	Lead ... pounds	120,000
Do	Newton	Granby	Granby Furnace	Granby Mining and Smelting Co	do	.....
Do	Saint François	Bonne Terre	Desloge Lead Furnace	Desloge Lead Co	do ... pounds	3,943,440
					Nickel and cobalt matte, pounds.	1,400,000
Do	do	do	Saint Joe Lead Co	Saint Joe Lead Co	Lead ... pounds	8,507,754
Do	do	Vallé's Mines	Silver Springs Furnace	Chadbourne & Foster	do ... do	43,200
Do	Saint Louis	South St. Louis	Glendale Zinc Works	Weyman & Co	Spelter ... do	2,502,427
Do	do	Carondelet	Carondelet Zinc Works	Carondelet Zinc Co	do ... do	1,656,000
Do	do	South St. Louis	Missouri Zinc Co	Missouri Zinc Co	do ... do	14,365,500
Do	do	Saint Louis	Saint Louis Chemical and Zinc Works.	Page & Krausse	Spelter and zinc oxide	.....
Do	do	do	Saint Louis S. and Ref. Co	Saint Louis S. and Ref. Co	Silver ... ounces	2,814,802
					Gold ... do	7,897
					Lead ... pounds	11,355,392
Do	Washington	Potosi	Perry Furnace	J. P. & R. M. Bugg	do ... do	471,380
Do	do	Old Mines	Old Mines Lead Co	Old Mines Lead Co	do ... do	495,545
Do	do	Fourche à Renault.	Long's Furnace	Wm. Long	do ... do	117,110
Do	do	Kingston township.	McGready's Furnace	F. E. McGready	do ... do	473,544
Do	do	Higginbothams' lead mines.	Davis' Lead Furnace	A. D. Davis	do ... do	43,200
Do	do	Kingston Furnace.	Higginbothams' Lead Furnace	Z. F. Higginbothams	do ... do	662,714
					Slag ... do	57,600
Do	do	do	Saint Louis Lead Mining Co	Saint Louis Lead Mining Co	Lead ... do	14,035
					Slag ... do	4,716
Do	do	Old Mines	White's Lead Furnace	T. S. White	Lead ... do	125,000
Do	do	Shibboleth	Shibboleth	John Latty	do ... do	307,441
Do	do	Palmer	Palmer Lead Co	Palmer Lead Co	do ... do	368,462
					Slag ... do	14,800
Do	do	Richwoods	Wilder's Lead Furnace	J. W. Wilder	Lead ... do	151,343
					Slag ... do	112,000
Do	do	Hopewell Furnace.	Hopewell Furnace	Heirs of John Evans	Lead ... do	313,600
Do	do	Richwoods	Flynn	T. Flynn	do ... do	171,720
Nebraska	Douglas	Omaha	Omaha Smelting and Refining Works.	Omaha Smelting and Refining Co	Lead, silver, and gold	.....
New Jersey	Camden	Camden	American Nickel Works	Joseph Wharton	Nickel	.....
Do	Essex	Newark	New Jersey Zinc Works	New Jersey Zinc Co	Zinc oxide	.....
Do	do	do	Newark Smelting and Refining Works.	E. Balbach & Son	Lead, silver, and gold	.....
Do	Hudson	Jersey City	Passaic Zinc Works	Passaic Zinc Co	Spelter and zinc oxide	.....
Do	do	Constable Hook	Bergen Point Zinc Works	F. Osgood & Co	do	.....
North Carolina	Ashe	Ore Knob	Ore Knob	Ore Knob Copper Co	Copper	.....
Pennsylvania	Allegheny	Mansfield valley	Pennsylvania Lead Co	Pennsylvania Lead Co	Refined pig-lead ... pounds	23,800,000
					Antimonial lead ... do	300,000
					Gold ... ounces	2,000
					Silver ... do	1,710,000
					Cu. matte ... pounds	220,000
Do	do	Pittsburgh	C. G. Hussey & Co	C. G. Hussey & Co	Cu. ingots ... do	467,458
Do	Chester	Phœnixville	Chemical Copper Co	Chemical Copper Co	.....	475,386
Do	Northampton	Bethlehem	Lehigh Zinc Works	Lehigh Zinc Co	Spelter and zinc oxide	.....
Tennessee	Jefferson	Leadvale	Leadvale Furnace	A. H. Gregg (receiver)	Lead	.....
Virginia	Pulaski	Martin's station	Bertha Zinc Works	Bertha Zinc Co	Spelter and zinc oxide	.....
Do	Wythe	Austinville	Austinville Furnace	Wythe Lead and Zinc Co	Lead	.....
Do	do	Reed island	Bertha Furnace	Bertha Zinc Co	Spelter and zinc oxide	.....
Vermont	Orange	Ely	Vermont Copper Mining Co	Vermont Copper Mining Co	Copper	.....
Wisconsin	Grant	New Diggings	New Diggings Furnace	Thomas G. Stevens & Co	Lead ... pounds	491,521
					Slag ... do	100,860
Do	do	do	Democrat or George Lerkley	Thomas and George Lerkley	Lead ... do	605,276
					Slag ... do	35,169
Do	do	Beetown	Hutchinson's Lead Furnace	Chris. Hutchinson	Lead ... do	340,811
Do	do	Potosi	Lightfoot Furnace	do	do ... do	483,323
Do	do	Platteville	Spensley & Straws	Spensley & Straws	do ... do	368,582
Do	do	Rockville	Ewing's Lead Furnace	A. W. Ewing	do ... do	105,000
Do	Iowa	Mineral Point	J. & C. Spenseley	J. & C. Spenseley	do ... do	242,739
Do	do	do	James Spenseley	James Spenseley	do ... do	300,000
Do	do	Dodgeville	Mundy, Pearce & Co	Mundy, Pearce & Co	do ... do	219,037
Do	do	Highland	Bennett, George & Co	Bennett, George & Co	do ... do	226,872
Do	do	Dodgeville	do	do	do ... do	480,680
Do	La Fayette	Shullsburg	Estey Furnace	B. Spenseley	do ... do	564,000
					Slag ... do	43,800
Do	do	Shullsburg Br'ch	Hutchinson	T. Hutchison	Lead ... do	154,194
Do	do	Hazel Green	Crawford, Mills & Co	John Fern	do ... do	420,504

Directory of mines of the minor minerals.

ASBESTUS.

State or territory.	County.	Locality.	Name of mine or company.	Name of operator.	Production.
					Tons.
Georgia	Fulton	Atlanta		Georgia Asbestos Mining Co	25
Maryland	Baltimore	Near Elysville		Gerald Emmart	2
Do	do	do		T. M. Hay	8
Do	do	do		Anthony Salmon	10
Do	Harford	Pylesville		H. C. Jenkins	20
New York	Richmond	Near Tompkinsville	Fielders Park	William Moffatt	50
North Carolina	Caldwell	8 miles west of Lenoir		W. M. Puett	None.
Do	Mitchell	Bakersville	Asbestos mine	Heap & Irby	None.
South Carolina	Pickens	Near Walhalla	Mickler mine	J. C. Mickler	35

ASPHALTUM.

					Tons.
California	Los Angeles	Eight miles west of Los Angeles	Rancho La Brea		300
Do	Santa Barbara	One mile south of Goleta	Moore Bros. Asphaltum		144

BARYTES.

					Tons.
Georgia	Bartow	Stegall's station		Woodward's barytes	200
Missouri	Washington	Mineral point	Boas		420
Do	do	Kingston furnace	Saint Louis Lead Mining Co		239
North Carolina	Gaston	Chowder's mountain	Chowder's Mountain Barytes		None.
Pennsylvania	Franklin	Mont Alto	Stamey	Mont Alto Iron Co	285
Virginia	Pittsylvania	Pullen's store	Morris	John S. Morris	1,904
Do	do	Berger's store	George H. Bliss & Co	George H. Bliss & Co	560

CHROMIC IRON.

					Tons.
California	San Luis Obispo	San Luis Obispo	London Iron mine	London Chrome Iron Mining Co	809
Do	do	4½ miles northeast of San Luis Obispo	Flores Iron mine		1,344
Maryland	Baltimore			Lake Chrome Mineral Co	100
Do	Harford	Jarrettsville	Jarrettsville	Tyson Mining Co	10
Pennsylvania	Lancaster	Wood mine	Wood mine	do	300

COBALT.

					Pounds.
Pennsylvania	Lancaster	Bart township	Gap Nickel mine	Joseph Wharton	10,337

CORUNDUM (EMERY).

					Tons.
Massachusetts	Hampden	Chester	Chester Emery mine	James T. Ames	600
North Carolina	Clay	Near Haysville	Buck Creek		None.
Do	Macon	Near Franklin	Corundum Hill	Hamden Emery Co	414
Do	Madison	Democrat	Carter mine	William H. Carter	None.
Do	do	Newlin	North Mine Co	North Mine Co	30

GARNET.

					Tons.
Pennsylvania	Delaware	Bethel township		Herman Behr & Co	60

GLASS SAND.

					Tons.
Illinois	La Salle	9 miles east of La Salle		De Steiger Glass Co	360
Indiana	Harrison	Posey township		Samuel Lawson	1,500
Do	do	do		W. De Pauw	2,000
Do	Washington	Jackson township		De Pauw American Plate Glass Co	2,924
Maryland	Anne Arundel	Near Waterbury		S. P. Spears	8,000
Do	do	do		Waite & Kerr	5,000
Do	do	Fork Creek		Edward Kerr	4,125

Directory of mines of the minor minerals—Continued.

GLASS SAND—Continued.

State or territory.	County.	Locality.	Name of mine or company.	Name of operator.	Production.
					Tons.
Massachusetts	Berkshire	Cheshire		Cheshire White Quartz Sand Co	2,000
Do	do	do	Gordon mine	Berkshire Glass Sand Co	5,000
Do	do	do		L. L. Brown	1,000
New Jersey	Camden	Near Winslow		Hay & Co	2,275
Do	Cumberland	Maurice river, below Millville		Samuel Hilliard	9,000
Do	do	South Vineland		J. Burns	1,500
Do	do	Near Bridgeton		Benjamin Lupton	3,000
Do	do	South Vineland		Osborn Bidwell	3,000
Do	Gloucester	Near Sicklestown		S. P. Spears	3,000
Do	do	do		Joseph Tourelson	700
Do	do	do		J. C. Semmerman	1,900
Do	do	do		Jacob Sickler	3,000
Do	do	Glassborough		Arthur Downer	3,000
Do	Salem			William Garrison	3,120
New York	Oneida	Near Durhamville		William Williams	600
Do	do	do		John Iles	1,500
Do	do	do		Andrew Durkee	2,000
Do	do	Dunbarton		Michael Butler	425
Do	Oswego	Cleveland		Charles Whitney	800
Do	do	Burnhard's Bay		J. B. Sickles	2,000
Do	do	do		S. P. Winn	800
Pennsylvania	Huntingdon			Samuel Hatfield, jr	5,000
Do	do			B. R. Faust & Son	12,000
Do	do			J. M. Maguire & Co	12,000
Do	Mifflin	McVeytown		Bradley & Dull	10,000
Do	do	Lewistown		Juniata Sand Co	12,523

GRAPHITE.

					Tons.
New York	Essex	Ticonderoga		Dixon Crucible Company	300
North Carolina	Wake	Near Raleigh	Heron mine	Carter, Pullen & Tucker	200
Pennsylvania				Graphite Mining and Manufacturing Co.	440

HYDRAULIC CEMENT.

					Barrels.
Georgia	Bartow	Cement	Waring Cement Works		10,000
Illinois	La Salle	Utica		James Clark	60,000
Do	do	do		John O. Pierson	60,000
Maryland	Alleghany	Cumberland		Cumberland Hydraulic Cement and Manufacturing Co.	4,000
Do	Washington			Bridges & Henderson	21,794
Michigan	Kalamazoo	Kalamazoo		Eagle Portland Cement Co	7,500
New York	Erie			Akron Cement Works	76,200
Do	do			Buffalo Cement Co., limited	103,367
Do	do			J. E. Newman & Co	82,517
Do	Onondaga	Fayetteville		Bangs & Gaynor	40,000
Do	Ulster			Newark Lime and Cement Co	220,530
Do	do			Connelly & Schafer	102,000
Do	do			New York and Rosendale	122,231
Do	do			Lawrenceville Cement Co	114,000
Do	do			James H. Oandenark	40,000
Do	do			Sherman Bros	55,000
Do	do			F. O. Norton	None.
Do	do	Binnewater			200,000
Do	do			Rosendale Cement Co	None.
Do	do			James Cement Co	53,564
Do	do			Hudson River Cement Co	80,000
Do	do			New York Cement Co	94,600
Do	do			Newark and Rosendale	137,000
Do	do			Cement Co	
Do	do			Warren Ackerman	68,000
Do	do			Lawrence Cement Co	132,000
Pennsylvania	Lawrence	Wampum		Wampum Cement and Lime Co. (lim.)	25,000
Do	Lehigh	Coplay		Coplay Cement Co	55,000
Virginia	Rockbridge			H. O. Locher & Co	4,050
West Virginia	Jefferson	Near Shepherdstown		Harry W. Blunt	4,500
Wisconsin	Milwaukee	Milwaukee	Milwaukee Cement Co.'s Works	Milwaukee Cement Co	108,000

Directory of mines of the minor minerals—Continued.

HYDRAULIC LIME.

State or territory.	County.	Locality.	Name of mine or company.	Name of operator.	Production.
					Bushels.
New York	Onondaga			M. Britton & Son	50,000
Do	do			E. B. Alvord & Co	149,932
Do	do			Robert Dunlap	60,000
Do	do			Bangs & Gaynor	300,000
Do	do			J. Sheedy & Son	90,000
Do	do			Behan & Co	100,000

INFUSORIAL EARTH.

					Tons.
Maryland	Calvert	Opposite Nottingham		Popplein Silicated Phosphate Co	1,800
New Jersey	Morris	Near Drakesville	Infusorial Earth	D. J. Cook	33

KAOLIN.

					Tons.
Delaware	New Castle			Israel Locy	3,010
Do	do			Hamilton Graham, jr	2,500
Do	do			Diamond State Kaolin Co	2,000
Do	do			Golding & Graham	7,000
Indiana	Lawrence	Spice Valley township	Lawrence County Kaolin	Pennsylvania Salt Manufacturing Co	1,000
Maryland	Cecil	Broad creek		William Hanna	250
New York	Dutchess	East Fishkill	American Kaolin	S. P. Wright	125
South Carolina	Aiken	Bath	Excelsior	R. McNamee & Co	5,600
Do	do	Beech Island	Beech Island Clay Works	Thomas J. Davis	1,792

MANGANESE.

					Tons.
Georgia	Bartow	Cartersville	Pyrolusite Manganese Mining Co	B. Woodward and W. H. Hackett	6,720
Virginia	Augusta	Turks gap	Turks Gap	Crimora Mining Co	3,050
Do	Campbell	Near Combined locks		W. H. Barclay	101
Do	do	Near Six-Mile Bridge		do	134
Do	Shenandoah	Paddy creek		Jos. M. Trask	84
Do	do	Johnson township		Powell's Fort Mining Co	624

MAGNESIAN LIMESTONE.

					Barrels.
Georgia	Bartow	Four miles from Cartersville		Ladd's Lime Works	15,000
Do	Catoosa	Graysville		Catoosa Lime Works	48,000

MICA.

					Pounds.
Maine	Oxford	Gilead	Peaked Hill	Maine Mica Mining Co	2,000
Massachusetts	Hampden	Chester		Chester Mica and Porcelain Co	1,000
New Hampshire	Grafton	Groton		American Mica Mining Co	2,000
Do	do	Grafton	Ruggles Mica Establishment	do	9,000
Do	do	Groton township		Hartford Mica Mining Co	25,000
Do	do	do		Crystal Mica Co	None.
New Jersey	Warren	Broadway	Broadway Mica	J. C. Merrill	None.
North Carolina	Buncombe		Yates Knob	Kelsey, Ray & Co	None.
Do	do		Bushier	do	None.
Do	do	Near Cooper's station	Brushy Mountain	do	None.
Do	do	do	Balsam Gap	do	None.
Do	Haywood	Waynesville	Big and Spruce Ridge	W. F. Gleason	1,000
Do	Jackson	Cullowhee	Davies or Forest Hill	D. D. Davies & Co	500
Do	do	do	Pressly		300
Do	do	Near Webster	Buchanan		100
Do	do	do	Trady	J. S. Bowers & Son	None.
Do	do	do	Shelton		None.
Do	do		Pine Mountain		None.
Do	do		Lesp. Mountain		None.
Do	do		Shell Ridge		None.

Directory of mines of the minor minerals—Continued.

MICA—Continued.

State or territory.	County.	Locality.	Name of mine or company.	Name of operator.	Production.
					Pounds.
North Carolina	Jackson	Near Webster	Stillwell	J. S. Bowers & Son	None.
Do	McDowell	Tom's creek	Tom's Creek	John Hyams & Bro	500
Do	Macon	Franklin	Iotla & Iola	Reid & Siler	2,000
Do	do	Burningtown	Burningtown	J. S. Bowers & Son	4,000
Do	do	Franklin	Abernethy	do	None.
Do	do	do	Saunders	do	None.
Do	do	do	Higdon	Higdon & McLean	None.
Do	do	do	Lyle's Mill	Dr. J. M. Lyle	None.
Do	do	do	Gayer	J. F. Ray & Bro	None.
Do	do	do	Lyle's Knob	A. S. Bryson	None.
Do	do	do	Smith	Rev. C. D. Smith	None.
Do	do	do	Allmond	N. G. Allmond	None.
Do	do	do	Raby	H. H. Raby	None.
Do	do	do	Moore	Col. T. B. Siler	None.
Do	do	do	Bald Mountain		None.
Do	do	do	Hall & Welch	Brooks & Co	None.
Do	do	do	Thorn Mountain	A. S. Bryson	None.
Do	do	do	Beasley, Bradley, Butte, and Mien City.		None.
Do	do	Franklin	Roaring Fork	C. D. Smith	None.
Do	do	do	Rocky Face	Ewing & Reid	None.
Do	Mitchell	Spruce Pine	Deake	J. K. Irby & Co	4,000
Do	do	Bakersville	Sink Hole	J. C. Phillips	175
Do	do	Hawk Mine	Hawk Mine	Miller & Green	600
Do	do	do	Spread Eagle	T. C. Green	2,667
Do	do		Young	D. M. Young	3,700
Do	do	Penland	Black Rock	J. K. Irby & J. M. Buchanan	1,200
Do	do	Hawk Mine	Clarissa	Thomas C. Green	18,000
Do	do	Spruce Pine	Childer	Gere, Gregory & Co	600
Do	do	Plumtree	Fenson Creek	Samuel Lander	None.
Do	do	Spruce Pine	Chestnut Flat	J. D. English	None.
Do	do	Bakersville	Point Pizzle		None.
Do	do	Spruce Pine	Chalk Mountain	Cox & Autrey	None.
Do	do	Hawk Mine	Hawk Mine No. 2		None
Do	do	Bakersville	Randolph	J. K. Irby	None.
Do	do		Reed	Samuel Lander	None.
Do	do	Spruce Pine	McHone		None.
Do	do	Plumtree	Lander	Samuel Lander	None.
Do	do		Blalock	J. K. Irby	None.
Do	do		Hollman		None.
Do	do		Rebel's Creek		None.
Do	do	Spruce Pine	Knob	J. D. English	None.
Do	do	Plumtree	Buch Hill	J. G. Wiseman and others	None.
Do	do	Spruce Pine	Crabtree Mountain	Cox & McNeil	None.
Do	do		Double Head	Samuel Lander	None.
Do	do	Plumtree	Franklin	do	None.
Do	do	Spruce Pine	Martin Wiseman		None.
Do	do		Lich Ridge	James McKinney	None.
Do	do		Westall	Gere, Gregory & Co	None.
Do	do	Spruce Pine	Grassy Creek		None.
Do	do	do	Rich Isaac		None.
Do	Yancey	Burnsville	Ray	Young & Proffitt	2,727
Do	do	Selo	James Gibbs	Moore & Bergen	200
Do	do		Zeff. Young	do	None.
Do	do		John Gibbs		None.
Do	do		Josh. Young		None.
Do	do		Seven-Mile Ridge		None.
Do	do		Black Mt. Westall	J. K. Irby	None.
Do	do		Poll. Robinson	Harry Moore	None.

MINERAL SOAP.

					Tons.
California	Ventura	9 miles west of San Buena Ventura	Ventura Rock Soap		None.
Nevada	Elko	16 miles south of Elko	Elko Mineral Soap Deposit		50

Directory of mines of the minor minerals—Continued.

NICKEL.

State or territory.	County.	Locality.	Name of mine or capacity.	Name of operator.	Production.
					Pounds.
Massachusetts	Middlesex	Draent	Draent Nickel M. Co		13,440
					Matte. pounds.
Missouri	Madison	Mine Lamotte			38,293
Do	Saint François	Bonne Terre	St. Joe Lead Mine		29,000
New Jersey	Warren	Brass Castle	Witty	C. F. Staates	None.
					Pounds.
Pennsylvania	Lancaster	Bart township	Gap Nickel Mine	Jos. Wharton	239,780

NICKEL AND COBALT.

					Pounds
Missouri	Saint François	Bonne Terre	Desloge		11,[illegible]

OCHER.

					Tons.
New Jersey	Monmouth	Near Englishtown		McGee, Clayton, Brighton & Van Winkle.	300
Vermont	Rutland			Crown Point Mineral Paint Co	200
Do	do			Brandon Mining Co	1,000
Do	do			Brandon Kaolin and Paint Co	450
Virginia	Page			Oxford Ocher Co	875
Do	Rockingham	Near Kerzletown	Hamilton	A. M. Hamilton	112

OIL-STONE.

					Pounds.
Indiana	Orange			A. Wolfington	20,000
Do	do	French Lick township		T. W. Braxton & Sons	150,000
Do	do				30,000

PYRITES.

					Tons.
New York	Saint Lawrence	De Kalb Junction	Bellings	G. H. Bellings	2,240

QUARTZ AND FELDSPAR.

					Tons.
Maryland	Cecil	Conowingo		B. G. & J. C. Smith	1,475
Do	Harford	Castleton		Trenton Flint and Spar Co	600
Do	do			J. & William P. Husband	1,400
Do	do			James T. Knight	351
Do	do			Jacob Supper	200
Massachusetts	Hampden			N. E. Judd	400
Do	do			Chester Mica and Porcelain Co	3,000
Michigan	Marquette	Goose lake		D. McVichie	5,000
Do	do	Carp river	Carp River Iron Co	Powell Bros	3,138
New Hampshire	Sullivan	Springfield		Globe Mica Mining Co	3,500
New York	Washington	Fort Ann		Bridgeport Wood Finishing Co	672
Do	do	do		A. Stevens	896
Do	do	do		R. N. Palmer	118
Do	do	do		F. M. Owen	221

SCYTHE-STONE.

					Gross.
New Hampshire	Grafton			A. E. Pike	5,000
Vermont	Washington			Hone and Scythe-Stone Co	100
Do	do			J. Wood & Son	75
Do	Windsor			A. B. Freeman & Son	500

Directory of mines of the minor minerals—Continued.

SHOEMAKERS' SANDSTONE.

State or territory.	County.	Locality.	Name of mine or capacity.	Name of operator.	Production.
					Pounds.
Indiana	Orange	French Lick township		T. W. Braxton & Sons	100,000
Do	do				50,000

SOAPSTONE.

State or territory.	County.	Locality.	Name of mine or capacity.	Name of operator.	Production.
					Tons.
Georgia	Cherokee	Holly Springs	Soapstone Quarry	Kerr & Ladd	200
Do	Murray	Near Dalton		William C. Tilton	120
Maryland	Baltimore	14 miles from Baltimore		Baltimore and North Branch Quarry Co.	300
New Hampshire	Hillsborough	Francestown	Soapstone Quarry	Williams & Co	2,000
North Carolina	Cherokee	Nottala	Brown	W. R. Johnston	450
Do	do	do	Hughes	J. Hughes	None.
Do	Swain	Nantehala river	Jones' Quarry	Beal & Hughes	60
Do	Franklin	Marion	Z. A. Ryder and D. O. Hitner	Z. A. Ryder & D. O. Hitner	11
Do	Montgomery	La Fayette station		Samuel F. Prince	4,000
Do	Windham			Butterfield & Smith	400
Do	do	Chester		Ira Holden	500
Do	Windsor			A. B. Freeman & Son	400

TALC.

State or territory.	County.	Locality.	Name of mine or capacity.	Name of operator.	Production.
					Tons.
New York	Saint Lawrence	Gouverneur township		Agolite Fiber Co	1,800
Do	do	do		Gouverneur Pulp Co	2,400
Do	do	do		Gouverneur Talc Co	10

WHETSTONE.

State or territory.	County.	Locality.	Name of mine or capacity.	Name of operator.	Production.
					Gross.
Vermont	Orleans		Willoughby Lake Quarry	J. C. Orne	1,400
Do	do	Near Evansville	Lamoville Quarry	A. F. Pike	1,500

Schedules were sent to Howe's Cave Lime and Cement Co., and to Howe's Cave Association, New York, both in active business, but no answers were received.

INDEX TO MINING INDUSTRIES.

NOTE.—The letters annexed to the page numbers indicate the position on the page of the matter referred to, and correspond generally to the marginal letters on the page. A few pages, including those containing the tables of analyses, were cast before this system was adopted, and are therefore without the marginal letters; but even with these, it is believed the use of letters in the index to indicate its position on the page will greatly facilitate finding the reference sought. In the list of iron-ore mines, given under each county, the following contractions have been used: L., for limonite; M., for magnetite; F., for fossil ore; H., for hematite, other than specular ore; H.(s), for specular hematite; C., for carbonate. The ordinary chemical symbols are used to indicate the elements determined by anaysis in the samples subjected to partial analysis only. If a complete analysis of a sample was made, this is indicated by a small letter c.

A.

ALABAMA.

Coal (bituminous), statistics of the production of, in c. y. (642–645, 674–675).

Iron. Amount in ore mined in c. y. and its per cent. of the total iron in the United States' ore product (19 d); amount of iron in the different kinds and grades of ore mined in the c. y. (28 d); average per cent. of iron in ore mined in c. y. (19 d).

Iron ore. Order of the state according to a mount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 d); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 d, 74 e); average value per ton (19 d); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 a); amount of each kind of ore mined in each county in the c. y. (23 d); amount of each kind and grade of ore, according to its contents of iron, mined in c. y. (27 f); amount of each kind and grade of ore, according to its phosphorous-iron ratio, mined in c. y. (29 d, 30 a); royalty paid on each kind of ore mined in c. y. (32 c).

Iron ore. Statistics of the production of iron ore in c. y. (40–43, 64–69); general averages of these statistics (70–71).

Iron ores. Partial analyses of (536–539); complete analyses of (584, 585).

Iron ores. Occurrence of the Clinton ores (13 e); character and position of the blackband ore (16 a).

Iron ores. Notes on the samples of iron ore collected in Alabama, by W. M. Chauvenet (383–399); iron-ore sample *map* of Alabama, geologically colored (Plate XXXV); *map* of northeast Alabama showing iron-ore deposits (384). SILURIAN LIMONITES.—Bibb county (383–387); Tuscaloosa county (385–387); Shelby county (387); Talladega county (387–389); Calhoun county (389, 391); Cherokee county (390–392). FOSSIL ORES.—Tuscaloosa county (392); Jefferson county (392–398); Saint Clair county (395); Etowahcounty (396–397); Cherokee county (398). CARBONIFEROUS LIMONITES.—Jefferson county (399). BLACKBAND ORES (399).

Iron ores. Notes on the samples of iron ore collected in Alabama, by Bailey Willis (400, 401); Calhoun county limonite (400); Clay county magnetite (400); Franklin county limonite (401); Lamar county limonite (401).

Bibb county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (23 d); statistics of the production of iron ore in, in c. y. (40–43); iron ore deposits of (383 e). Iron-ore mines: Briorfield furnace mine; L.; one sample: Fe,P. (387 a, 536 d). Burns mine; L.; one sample: Fe,P. (385 b, 536 d). De Bardeleben mine; L.; one sample: Fe,P. (385 c, 536 d). Edward's mine, see Burns mine (385 b, 536 d). Ray's, Dr., property; L.; two samples: Fe,P. (386 d, 536 d). Strickland mine; L.; two samples: Fe,P. (383 f, 385 a, 536 d).

Calhoun county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 d); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Glover mine; L.; one sample: Fe,P. (389 f, 536 f). Jacksonville mine; L.; one sample: Fe,P. (391 d, 538 a). Meadow mine, Pendergrass property; L.; one sample: Fe,P. (400 d, 538 d). Old Oxford mine; L.; one sample: Fe,P. (390 a, 536 f). Ridge mine; L.; one sample: Fe, P. (400 d, 538 d). Skinner mine; L.; one sample: Fe,P. (390 b, 536 f). Washer mine; L.; one sample: Fe,P. (390 c, 538 a).

ALABAMA—Continued.

Cherokee county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 d); statistics of the production of iron ore in c. y (40–43); iron ore deposits of (390 d, 398 e). Iron-ore mines: Brown mine; L.; one sample: Fe,P. (391 a, 538 b). Hardin mine; L.; one sample: Fe,P. (392 b, 538 c). Lower mine (Stonewall); L.; one sample: Fe,P. (390 e, 538 b). Rock Run Furnace mine; L.; one sample: Fe,P. (392 a, 538 b). Round Mountain Furnace mine; F.; three samples: Fe,P. (398 e, 538 c). Stonewall (Upper and Lower) mines; L.; two samples: Fe,P. 390 b, 538 b). Tecumseh furnace; L.; one sample: Fe,P. (391 c, 538 b). Tecumseh furnace mines, see Terry, Treadaway, Brown, and Tecumseh furnace (391 a, 538 b). Terry mine; L.; one sample: c. (391e, 538 b, 58 5). Treadaway mine; L.; one sample: Fe,P. (391 a, 538 b). Upper mine (Stonewall); L.; one sample: Fe,P. (390 f. 538 b).

Clay county. Kennedy (J. M.) mine; M.; one sample: Fe,P. (400 f, 538 c).

De Kalb county. Coal (bituminous), statistics of the production of, in c. y. (642–645). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 d); statistics of the production of iron ore in, in c. y. (40–43).

Etowah county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 d); statistics of the production of iron ore in c. y. (40–43); iron-ore deposits of (396 e). Iron-ore mines: Attala mine, see Rising Fawn mine and Rathburn, Foster & Winchester (397 d, 538 c). Rathburn, Foster & Winchester's property; F.; two samples: Fe, P. (397 d, 538 c). Rising Fawn (Attala) mine; F.; three samples: Fe, P. (396 f, 538 c); one sample: c. (397 e, 538 c, 585).

Franklin county. Iron ore mines: Fleming (T. B.) mine; L.; one sample: Fe,P. (401 c, 538 d). Sevier's (Dr.) mine; L.; one sample: Fe,P. (401 c, 538 d).

Jefferson county. Coal (bituminous), statistics of the production of, in c. y. (642–645). Iron ore: Amount of each kind of iron ore mined in, in c. y. (23 d); statistics of the production of iron ore in, in c. y. (40–43). Iron-ore mines: De Bardeleben mine (Birmingham ridge) F.; one sample: Fe,P. (394 c, 536 a); Eureka mine; F.; one sample: c; two samples: Fe,P. (393 d, 536 a, 584). Hickman mine; F.; three samples: Fe,P. (394 f, 536 b). Irondale furnace; F.; one sample: Fe,P. (394 d, 536, c). Little Red Mountain outcrop; F.; one sample: Fe,P. (398 a, 536 b). Massey's Mill outcrop, section (398 a); F.; one sample: Fe,P (398 c, 536 b). New Castle Station mine described; section; (399 c). C. (blackband); three samples: Fe,P. (399 d, 536 b). Old ore-pit near Cahaba river; L.; two samples: Fe,P. (399 a, 536 b c). Potter's (M. L.) property; F.; two samples: Fe,P. (392 f, 393 a, 536 c). Red mountain; F.; one sample: Fe,P. (393 b, 536 b). Rodgers' mine; F.; one sample: Fe,P. (398 d). Van's land; L.; one sample: Fe, P. (399 b, 536 b).

Jackson county. Coal (bituminous), statistics of the production of, in c. y. (642–645).

Lamar county. Vernon mine; L.; two samples: Fe,P. (401 d, 538 d).

Madison county. Coal (bituminous), statistics of the production of, in c. y. (642–645).

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Talladega county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (23 e); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Alabama furnace; L.; one sample: Fe,P. (387 f, 388 a, 536 f). Bed No. 6 (Clifton); L.; one sample: c. (388 f, 389 c, 536 f). Clifton mine; L.; two samples: Fe,P. (388 c, 536 c). Leay bed (Clifton); L.; one sample: Fe,P. (389 a, 536 f). Side mine; L.; one sample: Fe,P. (389 e, 536 f). Sparks mine; L.; one sample: Fe,P. (389 d, 536 f). Talladega mine; L.; one sample: Fe,P. (388 b, 536 e).

Tuscaloosa county. Coal (bituminous), statistics of the production of, in c. y. (642–645). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 e); statistics of the production of iron ore in, in c. y. (40–43); Iron-ore mines: Eureka Iron Company's mine; L.; one sample: c (386 a, 536 e, 584); one sample Fe,P (394 b, 536 e). Pioneer Iron Company's mine; L.; one sample: Fe,P. (385 d, 536 e). Shamblin and Dickey mine; F.; one sample: Fe,P. (392 e, 536 e). Shelby Coal Company (see Eureka mines), (394 b, 536 e). Tuscaloosa Iron Company's mine; L.; one sample: Fe,P. (385 f, 536 e). Woodward (S. H.); L.; one sample: Fe,P. (386 f, 536 e).

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Placer county. Clipper Gap mine; L. and M.; three samples: Fe,P. (494 f, 495 a, 538 d).

Santa Barbara county. Asphaltum, statistics of the production of, in c. y. (839).

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Las Animas county. Iron-ore deposits: El Moro mine; C.; one sample: Fe,P. (484 f, 538 f).
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Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 e); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 a); amount of each kind of ore mined in each county in the c. y. (24 a); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (27 f); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 d, 30 a).

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Iron ores. Geographical and geological distribution of, in the United States (3–36) (see Table of Contents for synopsis of this chapter); notes on the samples of iron ore collected in Alabama (383–399); notes on the samples of iron ore collected in Alabama (400–401); notes on the samples of iron ore collected in Connecticut and Massachusetts (83–87); notes on the samples of iron ore collected in east Tennessee (331–350); notes on the samples of iron ore collected in Georgia (367–378); notes on the samples of iron ore collected in Kentucky (289–300); notes on the samples of iron ore collected in Maryland (245–260); notes on the samples of iron ore collected in Michigan and northern Wisconsin (421–455); notes on the samples of iron ore collected in Missouri (403–420); notes on the samples of iron ore collected in New Jersey (145–177); notes on the samples of iron ore collected in New York (89–144); notes on the samples of iron ore collected in North Carolina (301–329); notes on the samples of iron ore collected in northern New England (79–82); notes on the samples of iron ore collected in Ohio (235–243); notes on the iron ores of Pennsylvania (179–221); report on certain magnetites in eastern Pennsylvania (223–234); notes on the samples of iron ore collected in Tennessee (351–365); notes on the samples of iron ore collected in Virginia (261–288); report of a trip to [the iron-ore deposits] of the Upper Mississippi and Vermilion lake (457–467); notes on the samples of iron ore collected west of the 100th meridian (469).

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Iron ore. Statistics of the production of, in c. y., by states and counties (48–63); statistics of the production of iron ore by states in c. y. (64–67); statistics of the production of, in c. y., by states (condensed table) (68, 69).

Iron-ore statistics, general analysis of, by C. F. Johnson (68–76); general averages of the statistics of the production of, by states (70, 71).

Iron ore, chromic, in California (304 c); chromic, statistics of the production of, by states and counties (839); by states (846–847).

Iron-ore mines of the United States, alphabetical list of. (See also *Directory of iron-ore mines*, pp. 931–976): **A.** Abram's creek (see Tenn., Blount co.); Adams mine (see Cal., Napa co.); Adams, Scott & Co. (No. 10½) mine (see Va., Amherst co.); Adelaide mine (see Utah, Iron co.); Aderholt (A. D.) mine (see Ala., Saint Clair co.); Ætna mine (see Tenn., Hickman co.);

Iron-ore mines of the United States, etc.—Continued.

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B. Bacon mine (see Mass., Berkshire co.); Bähler Farm mine (see Ohio, Tuscarawas co.); Baker mine (see N. J., Morris co.); Baker's mine (see Pa., Bedford co.); Baker's mine (Blair furnace) (see Pa., Blair co.); Baker mine (see Tenn., Johnson co.); Bald Pate mine (see N. J., Warren co.); Ballou's (N. P.) mine (see N. C., Ashe co.); Banagan and Shurlock mine (see Tenn., Stewart co.); Bank mine) see Mass., Berkshire co.); Bauman (Henry L.) (see Pa., York co.); Baraga mine (see Mich., Marquette co.); Barber (J.) & Co.'s mine (see Pa., Lehigh co.); Barnum mine (see Mich., Marquette co.); Barton Hill mine (see N. Y., Essex co.); Bartow furnace (see Ga., Bartow co.); Bastian's (Elwin) mine (see Pa., Lehigh co.); Bath mine (see Ky., Bath co.); Bays Branch mine (see Ky., Carter co.); Beach mine (see N. J., Morris co.); Beach Glen mine (see N. J., Morris co.); Bear's mine (see Pa., Cumberland co.); Bear Springs furnace (see Tenn., Stewart co.); Beaver mine (see Pa., Franklin co.); Bedford Pike mine (see Pa., Westmoreland co.); Bed No. 6 (Clifton) (see Ala., Talladega co.); Beehive mine (see Colo., Saguache co.); Beekman mine (see N. Y., Dutchess co.); Beer's mine (see N. J., Morris co.); Bell mine (see Tenn., Dickson co.); Bellwood mine (see Tenn., Stewart co.); Beltzhoover mine (see Pa., Cumberland co.); Benfield mine (see Pa., Berks co.); Bennett's mine (see N. Y., Wayne co.); Berring mine (see N. Y., Orange co.); Bessemer mine (see Mich., Marquette co.); Best's mine (see Pa., Cumberland co.); Bethel or Pittsfield mine (see Vt., Rutland co.); Bickle (Andrew) mine (see Pa., Snyder co.); Biery's (Jonas) mine (see Pa., Lehigh co.); Big bank (see Tenn., Unicoi co.); Big Creek mine (see Tenn., Campbell co.); Big Ivey mine (see N. C., Madison co.); Big mine (see Ga., Bartow co.); Big Ore mine (see N. C., Lincoln co.); Big Pond mine (see Pa., Cumberland co.); Billings mine (see Utah, Iron co.); Black mine (see Ga., Bartow co.); Black mine (see S. C., Union co.); Black Hill mine (see N. J., Morris co.); Blacklog Gap (near Orbisonia) mine (see Pa., Huntingdon co.); Blacklog Gap (south side of) mine (see Pa., Huntingdon co.); Blacklog Mountain mine (see Pa., Huntingdon co.); Black Magnetic mine (see Utah, Iron co.); Black River Falls mine (see Wis., Johnson co.); Black Stallion mine (see Utah, Utah co.); Blake mine (see Vt., Rutland co.); Blank's mine (see Pa., Lehigh co.); Blevin's (Armstead) mine (see Tenn., Johnson co.); Blevin's mine (Stony creek) (see Tenn., Carter co.); Bloomary Furnace mine (see W. Va., Hampshire co.); Bloomary mine (see N. C., Nash co.); Bloomfield mines (see Pa., Blair co.); Bloomsburg (Iron Company's) mine (see Pa., Snyder co.); Blowout Mountain mine (see Utah, Iron co.); Blue Springs mine (see Tenn., Unicoi co.); Bollinger's mine (see Pa., York co.); Bompass Cove mine (see Tenn., Unicoi co.); Boney's (D. S.) mine (see N. C., Duplin co.); Bortz's (Alwyn) mine (see Pa., Lehigh co.); Bortz & Koch's mine (see Pa., Lehigh co.); Boston mine (see Mich., Marquette co.); Bowen and Signors mine (see N. Y., Clinton co.); Bowen's mine (see Utah, Beaver co.); Bowers' Furnace mine (see Pa., Franklin co.); Bower's Spring Garden mine (see Md., Baltimore co.); Bowery mine (see Md., Alleghany co.); Bowman (farm) mine (see Ohio, Perry co.); Bowman mine (see Pa., Lebanon co.); Boyertown (Gable, Warwick, Phœnix, California) mines (see Pa., Montgomery co.); Brady's Bend (Iron Company) mine (see Pa., Armstrong co.); Brady mine (see Mo., Phelps co.); Brandon mine (see Vt., Rutland co.); Breece Iron mine (see Colo., Lake co.); Breinig's (Francis) mine (see Pa., Lehigh co.); Breinig's (Thomas) mine (see P., Lehigh co.); Brewster mine (see N. Y., Putnam co.); Bridge's (John) mine (see Pa., Cumberland co.); Brierfield furnace (see Ala., Bibb co.); Brinsmade mine (see N. Y., Essex co.); Brockley mine (see S. C., Spartanburgh co.); Brookpit mine (see Conn., Litchfield co.); Brotherton mine (see N. J., Morris co.); Brower mine (see Pa., Blair co.); Brown's mine (see Ala., Cherokee co.); Brown mine (see N. J., Passaic co.); Brown's mine (see Tenn., Roane co.); Brownbeck's (Frank) mine (see Pa., Berks co.); Brown and Musgrove's mine (see Pa., Armstrong co.);

Iron-ore mines of the United States, etc.—Continued.

Brown's forge (see Tenn., Johnson co.); Brown Hematite mine (see Va., Amherst co.); Brown's (Howard) mine (see Md., Anne Arundel co.); Brown or Shields mine (see N. J., Warren co.); Brown's (P.) mine (see Pa., Lehigh Co.); Brownsport furnace (see Tenn., Decatur co.); Brun mine (see Mich., Menominee co.); Bryan's mine (see Tenn., Montgomery co.); Bryant mine (see N. J., Morris co.); Bucher's mine (see Pa., Lebanon co.); Buchtel mine (see Ohio, Hocking, and Athens co.); Buckhorn mine (see N. C., Harnett co.); Budd mine (see N. J., Sussex co.); Buffalo Gap mine (see Va., Augusta co.); Bull mine (see N. Y., Orange co.); Bundy's mine (see N. Y., Wayne co.); Burns Company mine (see Tenn., James co.); Burns mine (see Ala., Bibb co.); Burford mine (see Ga., Bartow co.); Burke's (Sheriff William) mine (see Tenn., McMinn co.); Burline mine (see Ohio, Vinton co.); Burline mines and Torr farm (see Ohio, Vinton co.); Burton mine (see Tenn., Dickson co.); Butler mine (see N. J., Bergen co.); Butler mine (see N. Y., Oneida co.); Butler's mine (see Tenn., Johnson co.); Butz's mine (see Pa., Berks co.); Byram mine (see N. J., Morris co.). C. Cade's Cove (land of William Feezelle) mine (see Tenn., Blount co.); Caglin's mine (see N. Y., Oneida co.); Caledonia mine (see N. Y., Saint Lawrence co.); Calico mine (see Ga., Murray co.); Calico mine (see Pa., Cumberland co.); California mine (see Pa., Berks co.); Callie (old and new banks) mine (see Va., Botetourt co.); Calliman (Thomas) mine (see Pa., Franklin co.); Calumet mine (see Arkansas Hills, Colo., Chaffee co.); Cambria mine (see Mich., Marquette co.); Campbell and Barrett mine (see Pa., Armstrong co.); Camp Creek (George Babb's land) forge (see Tenn., Greene co.); Canada mines (see N. Y., Putnam co.); Canistear mine (see N. J., Sussex co.); Cannon mine (see N. J., Passaic co.); Cannon mine (see Tenn., Carter co.); Canterbury mine (see N. Y., Orange co.); Carden's (Wesley) mine (see Tenn., Carter co.); Caribou Hill mine (see Colo., Boulder co.); Carnes mine (see Va., Botetourt co.); Carpenter mine (see N. J., Warren co.); Carpenter mine (see Tenn., Blount co.); Carr mine (see Mich., Marquette co.); Carter mine (see Va., Wythe co.); Case mine (see N. J., Hunterdon co.); Casper mine (see Tenn., Unicoi co.); Cates (Charles) mine (see Tenn., McMinn co.); Catoctin or Runkel mine (see Md., Frederick co.); Cave mine (see Utah, Beaver co.); Cedar Grove furnace (see Tenn., Perry co.); Cedar Hill mine (see Tenn., Carter co.); Cedar Hill mine (see Mo., Iron co.); Center (No. 2) mine (see Ky., Lyons co.); Center Furnace mine (see Pa., Fayette co.); Chadwell Farm mine (see Va., Wythe co.); Chamber's (William L.) mine (see Pa., Franklin co.); Champion mine (see Mich., Marquette co.); Chapel Hill mine (see N. C., Orange co.); Chapin mine (see Conn., Litchfield co.); Chapin mine (see Mich., Menominee co.); Charlotteburg mine (see N. J., Morris co.); Chateaugay mine (see N. Y., Clinton co.); Chatfield mine (see Conn., Litchfield co.); Chattanooga (1½ mile south of) mine (see Tenn., Hamilton co.); Chauncy Leet mine (see Mass., Berkshire co.); Cheever mine (see Mass., Berkshire co.); Cheever mine (see N. Y., Essex co.); Cherry Valley Iron Company's mine (Capt. B. F. Lewis) (see Ohio, Columbiana co.); Cherry Valley mine (see Mo., Crawford co.); Cheshire mine (see Mich., Marquette co.); Chestnut Hill mine (see Del., New Castle co.); Chestnut Hill mine (see Pa., Lancaster co.); Chestnut mine (see Pa., Cumberland co.); Chestnut Mountain mine (see Va., Appomattox co.); Chicago mine (see Mich., Marquette co.); Chipman mine (see Vt., Rutland co.); Chumbler mine (see Ga., Bartow co.); Church mine (see N. J., Hunterdon co.); Clark's Farm mine (see Pa., Blair co.); Clark furnace (see Tenn., Stewart co.); Clark's (G. W.) mine (see Pa., Somerset co.); Clark mine (see Mo., Crawford co.); Clark Branch mine (see Tenn., Anderson co.); Cleveland mine (see Mich., Marquette co.); Clever's (George) mine (see Pa., Cumberland co.); Clever's (George H.) mine (see Pa., Cumberland co.); Clever's Mammoth mine No. 1 (see Pa., Cumberland co.); Clifton mine (see Ala., Talladega co.); Clifton Forge mine (see Va., Alleghany co.); Clinton mine (see Mo., Phelps co.); Clinton mine (see N. Y., Oneida co.); Clipper Gap mine (see Cal., Placer co.); Clove mine (see N. Y., Dutchess co.); Clove mine (see N. Y., Orange co.); Clove Spring mine (see N. Y., Dutchess co.); Clymer Iron Company's mine (see Pa., Berks co.); Cobb mine (see N. J., Morris co.); Coker's (Clift and Sawyers) mine (see Tenn., Hamilton co.); Coker's mine (see Tenn., Hamilton co.); Cold Creek mine (see Utah, Weber co.); Cole's (George) mine (see Pa., Adams co.); Cole mine (see N. C., Moore co.); Cole's River mine (see W. Va., Monongalia co.); Columbia mine (see Mich., Marquette co.); Columbia Spathic Iron Company's mine (see N. Y., Columbia co.); Colwell (J. A.) mine (see Pa., Armstrong co.); Combs mine (see N. J., Morris co.); Commonwealth mine (see Wis., Marinette co.); Cone mine (see Mass., Berkshire co.); Connor mine (see Ga., Bartow co.); Conrad (Dr. J. D.) mine (see Pa., Snyder co.); Cook mine (see Smith mine, Essex co.); Cooper & Hewitt's mine (see N. Y., Richmond co.); Cooper mine (see N. J., Morris co.);

Iron-ore mines of the United States, etc.—Continued.

Copake mine (see N. Y., Columbia co.); Cornell mine (see Mich., Menominee co.); Cornwall mine (see Pa., Lebanon co.); Costner mine (see N. C., Gaston co.); Cove mine (see Tenn., Johnson co.); Cranberry mine (see N. C., Mitchell co.); Crawford mine (see N. Y., Orange co.); Cregar mine (see under N. J., Hunterdon co.); Creola mine (see Dunkel mine, Ohio, Vinton co.); Cressler's (John H.) mine (see Pa., Cumberland co.); Cressler's (Joseph) mine (see Pa., Franklin co.); Crockett mine (see Tenn., Sullivan co); Croft mine (see N. Y., Putnam co.); Crown Point mine (see N. Y., Essex co.); Cross-cut (Archer's creek) mine (see Va., Appomattox co.); Cross Mountain mine (see Tenn., Johnson co.); Crowder's mountain mine (see N. C., Gaston co.); Crow mine (see Ga., Bartow co.); Cruikshank & Bro.'s mine (see Pa., Snyder co.); Crumbler (property) mine (see Pa., Perry co.); Cumberland furnace banks (see Tenn., Dickson co.); Curd's mine (see Tenn., Monroe co.); Curtis mine (see N. C., Caldwell co.); Curry mine (see Mich., Menominee co.); Cyclops mine (see Mich., Menominee co.). **D.** Dafford mine (see N. J., Hunterdon co.); Dakin mine (see N. Y., Dutchess co.); Dalliba mine (see Mich., Marquette co.); Dalrymple mine (see N. J., Morris co.); Danbury mine (see N. C., Stokes co.); Daney's (Elias) mine (see Pa., Lehigh co.); Dannemora mine (see N. C., Rockingham co.); Davenport mine (see N. J., Sussex co.); David's (widow) mine (see Tenn., Scott co.); Davis mine (see N. Y., Oneida co.); Davis mine (see Ohio, Lawrence co.); Davis mine (see Tenn., Lawrence co.); Davis (or Forbes) mine (see Conn., Litchfield co.); Dean's mine (see Pa., Blair co.); De Bardeleben mine (see Ala., Bibb co.); De Bardeleben mine (see Ala., Jefferson co.); De Bow mine (see under N. J., Morris co.); De Camp (or Upper Wood) mine (see N. J., Morris co.); Decatur furnace (see Tenn., Decatur co.); De Hart mine (see N. J., Morris co.); Denman (William) mine (see Ohio, Columbiana co.); Denmark mine (see N. J., Morris co.); Denny's mill mine (see Pa., Butler co.); Denny mine (see N. Y., Putnam co.); Denny mine (see Pa., Dauphin co.); Derwin's farm mine (see N. Y., Oneida co.); Dickerson mine (see N. J., Morris co.); Dickey mine (see Va., Alleghany co.); Dickson mine (see N. Y., Jefferson co.); Diggin's (Jos.) mine (see Pa., Huntingdon co.); Dillsburg mines (see Pa., York co.); Diven mine (see Pa., Cumberland co.); Dobbins's mine (see Ga., Bartow co); Dodge mine (see N. J., Morris co.); Dolly Ann mine (see Va., Alleghany co.); Donaldson's (Judge) mine (see Ga., Cherokee co.); Donnelly's mine (see Tenn., Johnson co.); Donnelly's mine (see Tenn., Monroe co.); Douglas mine (see Pa., Huntingdon co.); Douglass' (Wyeth) mine (see Pa., Franklin co.); Dover Company's (No. 6) mine (see Va., Amherst co.); Dover Company's (No. 11) mine (see Va., Amherst co.); Dover Furnace Hill mine (see Ohio, Tuscarawas co.); Dover mine (see N. Y., Dutchess co.); Dover (near) mine (see Ohio, Tuscarawas co.); Dragon mine (see Utah, Juab co.); Drake's (Henry) mine (see Tenn., Dickson co.); Ducktown mine (see Tenn., Polk co.); Duggers (James) mine (see Tenn., Carter co.); Dull and Bradley's (see Pa., Huntingdon co.); Dull (I. J.) mine (see Pa., Mifflin co.); Duncan mine (see Utah, Iron co.); Dunkel mine (see Ohio, Vinton co.); Dugan's (S. S.) mine (see Ky., Carter co.); Dye bank (see Ohio, Tuscarawas co.). **E.** Eagle furnace mine (see Ohio, Vinton co.); Eagle mine (see Wis., Marinette co.); Earnest's (John) mine (see Pa., Snyder co.); East Bellwood mine (see Tenn., Stewart co); Edward's mine (see Ala., Bibb co.); Edward's mine (see Mich., Marquette co.); Egbert mine (see N. J., Warren co.); Ege mine (see Pa., Cumberland co.); Eller's (Big creek) mine (see N. C., Madison co.); Ellingwood mine (see N. Y., Oneida co.); Elliott mine (see N. Y., Oneida co.); Ellison mine (see N. C., Gaston co.); El Moro mine (see Col., Las Animas co.); Emmet mine (see Mich., Menominee co.); English mine (see Pa., Franklin co.); Ensor mine (see Md., Frederick co.); Estill Furnace mine (see Ky., Estill co.); Etna Furnace mine (see Pa., Blair co.); Eureka Iron Company's mine (see Ala., Tuscaloosa co.); Eureka mine (see Ala., Jefferson co.); Evan's mine (see N. C., Chatham co.); Eveland mine (see N. J., Hunterdon co.); Evers mine (see N. J., Morris co.); Excelsior and Chesapeake mine (see Utah, Iron co.); Excelsior mine (see Mich., Marquette co.). **F.** Falkner mine (see Pa., Blair co.); Far Mountain mine (see Tenn., Johnson co.); Fayette Furnace mine (see Pa., Fayette co.); Ferguson mine (see Tenn., Carter co.); Ferguson Valley mine (see Pa., Mifflin co.); Ferris mine (see N. C., Surry co.): Ferro Hill mine (see N. Y., Orange co.); Fig and Bayley mine (see Tenn., Stewart co.); "First Vein" (east of "Old Furnace Vein") (see Va., Amherst co.); Fisher's Creek mine (see Ga., Polk co.); Fisher's (Francis) mine (see Pa., Lehigh co.); Fisher Hill mine (see N. Y., Essex co.); Fishing Creek mine (see Pa., Centre co.); Fishkill mine (see N. Y., Dutchess co.); Fitzwater mine (see Mo., Dent co.); Flat o' the Mountain mine (see Tenn., Blount co.); Fleetwood Iron Company's mine (see Pa., Berks co.); Fleming's (T. B.) mine (see Alabama, Franklin co.); Florence (or Eagle) mine (see Wis., Marinette co.); Flower Branch mine (see Ga., Floyd co.); Fogel's (William B.) mine (see Pa., Lehigh co.); Folger mine (see Ga., Polk co.); Forbes (or Davis) mine (see Conn., Litchfield co.); Ford mine (see N. J., Morris co.); Forest City mine (see Mich., Marquette co.); Forestdale or Blake mine (see Vt., Rutland co.); Forest of Dean mine (see N. Y., Orange co.); Forney mine (see N. C., Lincoln co.); Forshee mine (see N. Y., Orange co.); Foster mine (see Mich., Marquette co.); Fox Farm mine (see Pa., Clarion co.); Fox Mountain (Shenandoah Iron Works) mine (see Va., Rockingham co.); Franconia mine (see N. H., Grafton co.); Franklin and Clinton mine (see N. Y., Oneida co.); Frazeysburg mine (see Goff, McGinnis, Millstead, McDonald mines) (see Ohio, Muskingum co.); Fredericks mine (see Pa., Berks co.); French Creek mine (see Pa., Chester co.); Friel and Millbrook's mine (see Md., Prince George co.); Friend mine (see Wyo., Carbon co.); Frisco Mining and Smelting Company's mine (see Utah, Beaver co.); Fritch & Brothers' mine (see Pa., Berks co.); Fritz mine (see Pa., Berks co.); Frost mine (see Md., Alleghany co.); Fuller's (Dr.) mine (see Pa., Fayette co.); Fulton mine (see Ky., Lyon co.); Furgerson (Iron Hill furnace) mine (see Ky., Carter co.); Furnace Run mine (see Pa., Lycoming co.); Furnace View mine (see N. J., Sussex co.); Furstenburg (furnace) mine (see Md., Baltimore co.); Furstenburg mine (see Md., Baltimore co.). **G.** Gable mine (see Pa., Berks co.); Gackenbach's mine (see Pa., Lehigh co.); Gallic mine (see Pa., Franklin co.); Gaston (5 miles south of) mine (see N. C., Halifax co.); Gates or Putnam mine (see N. Y., Essex co.); Gay and Lewis mine (see Va., Alleghany co.); Geary's (Charles) mine (see Pa., Berks co.); Gee Creek Gap mine (see Tenn., Polk co.); George's (Benjamin) mine (see Pa., Franklin co.); Giton mine (see Ga., Bartow co.); Givens' (A.) mine (see Va., Alleghany co.); Glade mine (see Va., Wythe co.); Glendon mine (see Hibernia mines) (see N. J., Morris co.); Glick's (Charles) mine (see Pa., Lehigh co.); Glover mine (see Ala., Calhoun co.); Gochenauer and Rohrer's mine (see Pa., Franklin co.); Godfrey mine (see Vt., Bennington co.); Goff mine (see Ohio, Muskingum co.); Good's (Michael) mine (see Pa., Franklin co.); Goodrich mine (see Mass., Berkshire co.); Goodrich mine (see Mich., Marquette co.); Gore furnace mine (see Ohio, Hocking co.); Gorgas mine (see Pa., Cumberland co.); Gove mine (see N. J., Morris co.); Grace or Ferrol mine (see Va., Augusta co.); Graham mine (see Pa., Juniata co.); Grammis' (Jacob) mine (see Pa., Lehigh co.); Grand Union and Mozelle mine (see Mo., Phelps co.); Granger or Pittsford mine (see Vt., Rutland co.); Grave-yard mine (see Tenn., Stewart co.); Gray mine (see Ga., Bartow co.); Gray mine (see N. J., Hunterdon co.); Greasy Creek mine (see N. C., Mitchell co.); Great Western mine (see Utah, Iron co.); Green mine (see N. J., Sussex co.); Green Pond mine (see N. J., Morris co.); Greene Ridge mine (see Tenn., Greene co.); Green Spring mine (see Md., Baltimore co.); Greenway mine (see Va., Nelson co.); Greenwood furnace (4 miles from) mine (see Pa., Huntingdon co.); Greenwood mine (see N. Y., Orange co.); Greise & Wendling's mine (see Pa., Berks co.); Gribben mine (see Mich., Marquette co.); Gridley mine (see N. Y., Dutchess co.); Griffith's Jerome) mine (see Tenn., Monroe co.); Grim's mine (see Md., Frederick co.); Groeble Farm mine (see Ohio, Tuscarawas co.); Groh mine (see Pa., Lebanon co.); Grove mine (see Pa., Cumberland co.); Grun's mine (see Tenn., James co.); Guilford mine (see Pa., Franklin co.); Guiterman's mine (see Pa., Berks co.); Gulf mine (see N. C., Chatham co.); Guth's (Calvin) mine (see Pa., Lehigh co.); Guth's (Francis) mine (see Pa., Lehigh co.). **H.** Hacklebarney mine (see N. J., Morris co.); Hager mine (see N. J., Hunterdon co.); Haight mine (see N. Y., Columbia co.); Haine & Klutz's mine (see Pa., Berks co.); Hale mine (see N. Y., Essex co.); Hale mine (see Tenn., Monroe co.); Half-Moon mine (see W. Va., Grant co.); Hamilton mine (see Colo., Park co.); Hampton's mine (see N. C., Ashe co.); Hamum's (Dr.) mine (see Tenn., Unicoi co.); Hankwell's (William) mine (see Pa., Juniata co.); Hann mine (see N. J., Morris co.); Hanover Switch mine (see Md., Hanover co.); Hardin mine (see Ala., Cherokee co.); Hard ore mine (see N. C., Stokes co.); Harris's (I. R.) mine (see Ga., Murray co.); Hawkins mine (see Mo., Dent co.); Hayes mine (see Pa., Lycoming co.); Hecla mine (see Arkansas Hills, Colo., Chaffee co.); Hecla furnace mine (see Ohio, Lawrence co.); Heike's mine (see Pa., Cumberland co.); Heits mine (see Ohio, Tuscarawas co.); Heffner's (Charles) mine (see Pa., Berks co.); Hegeman or Smith mine (see Md., Baltimore co.); Hematite mine (see Utah, Utah co.); Heninger's (John) mine (see Pa., Lehigh co.); Henrietta mines (see Pa., Blair co.); Henry Clay mines, Nos. 1, 2, and 3 (see Pa., Cumberland co.); Henry's (John) mine (see Ohio, Columbiana co); Hensinger Heirs' mine (see Pa., Lehigh co.); Hewitt mine (see N. J., Passaic co.); Hibernia mines (see N. J., Morris co.); Hickman mine (see Ala., Jefferson co.); Hickory Hill mine (see N. J., Morris co.); Hickory Hollow or Salisbury mine (see Va., Botetourt co.); Hick's mine (see Pa., Huntingdon co.); High Bridge mine

Iron-ore mines of the United States, etc.—Continued.
(see N. J., Hunterdon co.); High Ledge mine (see N. J., Morris co.); Hill and Tarwater mine (see Tenn., Rhea co); Hill mine (see N. J., Sussex co.); Hill mine (see N. Y., Putnam co.); Hill mine (see Tenn., McMinn co.); Hillsdale mine (see N. Y., Columbia co.); Hinch's mine (see Tenn., Bradley co.); Hindman's mine (see Pa., Clarion co.); Hirsh and Hiestand mine (see Pa., Juniata co.); Hodge mine (see Tenn., Carter co.); Hogencamp mine (see N. Y., Orange co.); Hoggsett, Watt & Co.'s mine (see Pa., Fayette co.); Holland's (Trickum) mine (see Ga., Whitfield co.); Hollidaysburg and Gap Iron Company's mine (see Pa., Blair co.); Hollidaysburg mine (see Pa., Blair co.); Hollow bank (see Va., Shenandoah co.); Horner mine (see Pa., Blair co.); Hoover's (R.) mine (see Pa., Bedford co.); Hope mine (see N. J., Passaic co.); Hope mine (Mont Alto Iron Company) (see Pa., Franklin co.); Hope mine (see W. Va., Monongalia co.); Hopewell mine (see Pa., Chester co.); Horse Creek (J. and C. Graybeal's) mine (see N. C., Ashe co.); Horse Hollow mine (see Mo., Phelps co); Horton's (J. L.) mine (see N. C., Chatham co.); Houck and Granniss' mine (see Pa., Lawrence co.); Howard mine (see Pa., Centre co.); Huddleson mine (see Va., Alleghany co.); Hude or Stanhope mine (see N. J., Sussex co.); Hudson Drift mine (see Ohio, Lawrence co.); Huffine's mine (see Tenn., Washington co.); Huff mine (see N. J., Morris co.); Hugh Kelley mine (see Ohio, Tuscarawas co.); Humboldt mine (see Mich., Marquette co.); Hunnewell furnace mine (see Ky., Greenup co.); Hurley Brothers' mine (see N. Y., Wayne co.); Hurley mine (see Tenn., Carter co.); Hurd mine (see N. J., Morris co.); Hurdtown mine (see N. J., Morris co.); Hurst mine (see Va., Wythe co.); Hyatt mine (see N. C., Surry co.). **I.** Ice Ferry mine (see W. Va., Monongalia co.); Indiana mine (see Mich., Marquette co.); Irish mine (see Ga., Bartow co.); Irondale furnace (see Ala., Jefferson co.); Irondale mine (see N. J., Morris co.); Iron Hill mine (see Del., New Castle co.); Iron Hill mine (see Ky., Carter co.); Iron Hill mine (see R. I., Providence co.); Iron Hill mine (see Tenn., Rhea co.); Iron Mountain mine (see Colo., Fremont co.); Iron Mountain mine (see Mo., Saint François co.); Iron Mountain mine (see Wyo., Laramie co.); Iron Point mine (see Ohio, Perry co.); Ironton Railroad Company's mine (see Pa., Lehigh co.); Iron Ridge mine (see Mo., Crawford co.) **J.** Jackson mine (see Mich., Marquette co.); Jackson Mountain mine (see Nev., Humboldt co.); Jacksonville mine (see Ala., Calhoun co.); Jacob's Creek mine (see Pa., Westmoreland co.); Jalapa mine (see Tenn., Monroe co.); Janett's mine (see Ga., Fannin co.); Jayville (Alpine furnace) mine (see N. Y., Saint Lawrence co.); Jefferson County mine (see Colo., Jefferson co.); Jobst's (H. and F.) mine (see Pa., Lehigh co.); Johnsey mine (see Ga., Bartow co.); Johnson mine (see Va., Pulaski co.); Johnson mine (see Va., Wythe co.); Johnson mine (see W. Va., Monongalia co.); Johnson's ridge of Elk Knob (see N. C., Ashe co.); Jones (Jennings) mine (see Pa., Franklin co.); Jones mine (see Pa., Berks co.); Junction City mine (see Ohio, Vinton co.). **K.** Kahart mine (see N. J., Morris co.); Kaiser's (Harry) mine (see Pa., Lehigh co.); Kane (or Silverhorn) mine (see N. J., Hunterdon co.); Katahdin mine (see Me., Piscataquis co.); Kearney mine (see N. Y., Saint Lawrence co.); Keck and Ritter's mine (see Pa., Lehigh co.); Keel Ridge mine (see Mich., Menominee co.); Keene mine (see N. Y., Jefferson co.); Keener mine (see Tenn., Unicoi co.); Kehm's (Solomon) mine (see Pa., Lehigh co.); Kelley mine (see Md., Baltimore co.); Kendrick's mine (see Tenn., Meigs co.); Kennedy's (J. M.) mine (see Ala., Clay co.); Kennedy mine (see Va., Augusta co.); Kent mine (see Conn., Litchfield co.); Keystone mine (see Mich., Marquette co.); Killian mine (see N. C., Lincoln co.); King mine (see N. J., Morris co.); King mine (see Tenn., Johnson co.); Kingston (2 miles west of) mine (see Ga., Bartow co.); Kinzer's (John) mine (see Pa. Mifflin co.); Kishpaugh mine (see N. J., Warren co.); Klein's mine (see N. Y., Oneida co.); Kline's (D. K.) mine (see Pa., Berks co.); Kline's (Henry) mine (see Pa., Lehigh co.); Kline's (James) mine (see Pa., Lehigh co.); Kline's (Jesse) mine (see Pa., Lehigh co.); Koontz and Meyers mine (see Pa., Cumberland co.); Koser's (Jacob) mine (see Pa., Franklin co.); Kraemlich and Lichtenwalner's mine (see Pa., Lehigh co.); Kreischmann's mine (see Pa., Lehigh co.); Kurtz's (widow) mine (see Pa., Lehigh co.). **L.** La Frois's (J.) mine (see N. Y., Wayne co.); La Grange mine (see Tenn., Stewart co.); Lake Angeline mine (see Mich., Marquette co.); Lake Mahopac (island) (see N. Y., Putnam co.); Lake mine (see N. Y., Orange co.); Lake Superior hematite mine (see Mich., Marquette co.); Lake Superior mine (see Mich., Marquette co.); Lake Superior mine (see Utah, Beaver co.); Lambert mine (see Ky., Carter co.); Lamb mine (see Mo., Phelps co.); Lamb mine (see Tenn., Greene co.); Lane mine (see Pa., Huntingdon co.); Large's mine (see N. J., Hunterdon co.); Laro's (Jesse) mine (see Pa., Lehigh co.); Lawrence mine (see N. J., Morris co.); Lauer's (Milton) mine (see Pa., Lehigh co.); Laurel Fork mine (see Tenn., Johnson co.); Laurel mines Nos. 1 and 2 (see Pa., Cumberland co.); Lawrenceburg (six miles southwest of) mine (see Tenn., Lawrence co.); Lawrence furnace (see Ohio, Lawrence co.); Lawrence mine (see N. J., Morris co.); Lead mine (see Tenn., Washington co.); Leaybed (Clifton) mine (see Ala., Talladega co.); Lee mine (see N Y., Essex co.); Lee mine (see S. C., York co.); Leet's (Nathaniel) mine (see Mass., Berkshire co.); Lehman's (J. C.) mine (see Pa., Cumberland co.); Leib mine (J. S. Whitmer & Co.) (see Pa., Franklin co.); Leicester mine (see Vt., Addison co.); Leidig & Hoffer mine (see Pa., Cumberland co.); Lemont Furnace mine (see Pa., Fayette co.); Levan's (Daniel) mine (see Pa., Lehigh co.); Lewis' (Capt. B. F.) mine (see Ohio, Columbiana co.); Lewis mine (see W. Va., Grant co.); Lewis' (Samuel) mine (see Pa., Berks co.); Lewistown Section mine (see Pa., Mifflin co.); Lichtenwalner's (Frank S.) mine (see Pa., Lehigh co.); Lichtenwalner's (Levi) mine (see Pa., Lehigh co.); Lime Kiln mine (see Pa., Franklin co.); Limestone Ridge Mining Company's mine (see Pa., Perry co.); Linthicum's (A. S.) mine (see Md., Anne Arundel co); Lips mine (see Tenn., Carter co.); Little's mine (see N. C., Cherokee co.); Little Kearney mine (see N. Y., Saint Lawrence co.); Little Red Mountain outcrop (see Ala., Jefferson co.); Lone Mountain mine (see Tenn., Anderson co.); Longdale mine (see Va., Alleghany co.); Love's Furnace mine (see Tenn., Sevier co); Lowe mine (see Tenn., Hamilton co.); Lowell mine (see Mich., Menominee co.); Lower mine (see Ala., Cherokee co.); Lowe's (S. B.) mine (see Ga., Polk co.); Lower or Third (one mile northwest of Mansfield) mine (see Pa., Tioga co.); Lower Wood mine (see N. J., Morris co.); Lowmore mine (see Va., Alleghany co.); Lowthian mine (see Mich., Marquette co.); Lucy's mine (see Pa., Franklin co.); Ludington mine (see Mich., Menominee co); Ludwig's New mine (see Pa., Lehigh co.); Ludwig's Old mine (see Pa., Lehigh co.). **M.** Mayberry mine (see N. J., Hunterdon co.); Magiffin (J. S.) mine (see Pa., Fayette co.); Mahopac mine (see N. Y., Putnam co.); Main bank (see Tenn., Washington co.); Maltby mine (see N. Y., Dutchess co.); Manganese mine (see Mich., Marquette co.); Manhattan mine (see N. Y., Dutchess co.); Mann's (J. H.), Logan Gap mine (see Pa., Mifflin co.); Mantooth (James) mine (see Tenn., Cocke co.); Maple Grove Mill mine (see Pa., Lehigh co.); Marck's (P.) mine (see Pa., Lehigh co.); Marion mine (see Tenn., Wayne co.); Marshall mine (see Colo., Boulder co.); Marshall mine (see Utah, Iron co.); Marsh mine (see Mo., Crawford co.); Martin's mine (see W. Va., Mineral co.); Maryland or Ellicott's mine (see Md., Baltimore co.); Mason and Bliss mine (see Mass., Berkshire co.); Massey's Mill mine (see Ala., Jefferson co.); Mast mine (see Tenn., Johnson co.); Matilda Furnace mine (see Pa., Mifflin co.); Maud vein, Stapleton mine (see Va., Amherst co.); Maxwell (land grant) mine (see N. Mex., Colfax co); Maxwell mine (see Tenn., Carter co.); May's mine (see Va., Botetourt co.); McAleary's mine (see Pa., Huntingdon co.); McCarthy's mine (see Pa., Huntingdon co.); McCleary's (Robert) mine (see Pa., Franklin co.); McClellan mine (see Colo., Saguache co.); McCollum mine (see N. Y., Putnam co.); McComber mine (see Mich., Marquette co.); McCormick's (Robert) mine (see Pa., Mifflin co.); McCreechan's mine (see Pa., Cumberland co.); McDonnald mine (see Ohio, Muskingum co.); McFarland's (R. P.) mine (see Pa., Franklin co.); McGarvey mine (see Mo., Crawford co.); McGinnis mine (see Ohio, Muskingum co.); McGowan (Stewart's run) mine (see Pa., Lycoming co.); McHose mine (see Pa., Franklin co.); McKee's (George) mine (see Pa., Mifflin co.); McKenna mine (see Mich., Menominee co.); McLaughlin's (J.) mine (see Ohio, Perry co.); McNeal mine (McCormick & Co.) (see Pa., Franklin co.); McPheese mine (see Pa., Blair co.); McVeytown gap, Rose mine (see Pa., Franklin co.); Meadow (Pendergrass property) mine (see Ala., Calhoun co.); Means mine (see Pa., Franklin co.); Mentzer's (David) mine (see Pa., Franklin co.); Merkel's (Mrs. John) mine (see Pa., Berks co.); Michael's mine (see W. Va., Grant co.); Michigamme mine (see Mich., Marquette co.); Middle or Second (on Bixby's hill) mine (see Pa., Tioga co.); Miller pit (see N. Y., Essex co.); Miller's (Charles) mine (see Pa., Berks co.); Miller's (Charles) mine (see Pa., Lehigh co.); Miller mine (see Va., Rockingham co.); Miller's (William) mine (see Pa., Berks co.); Millon mine (see N. J., Morris co.); Millstead mine (see Ohio, Muskingum co.); Milsap and Orchard mine (see Mo., Dent co.); Milton mine (see Ohio, Jackson co.); Milwaukee mine (see Mich., Marquette co.); Mine 21 (see N. Y., Essex co.); Mine 81 (see N. Y., Clinton co.); Mine Mountain mine (see N. C., Gaston co.); Mine ore-bank (see Pa., York co.); Mine Ridge mine (James Mantooth), (see Tenn., Cocke co.); Mineral Ridge (Tod, Wells & Co.) mine (see Ohio, Columbiana co.); Mineville mines (see N. Y., Essex co.); Missouri Furnace Company's mine (see Mo., Saint Louis co.); Mitchell mine (see Mich., Marquette co.); Mitchell mine (see N. Y., Columbia co.); Mitchell, Wilson, and Riley's mine (see Md., Anne Arundel co.); Money's mine (see Utah, Beaver co.); Monkton mine (see Vt., Addison co.); Monroe furnace (see Ohio, Jackson co.); Montauk (or Beach) mine (see N. J., Morris co., mine); Monteith's mine (see N. C., Cherokee co.); Morse's mine (see N. C., Cherokee co.); Mory's

Iron-ore mines of the United States, etc.—Continued.

(G. and W.) mine (see Pa., Lehigh co.); Mory's (Morgan) mine (see Pa., Lehigh co.); Moselem mine (see Pa., Berks co.); Moser's (Oliver) mine (see Pa., Lehigh co.); Mound mine (see Tenn., Stewart co.); Mountain mine (see Pa., Huntingdon co.); Mountain Peak mine (see Utah, Iron co.); Mount Alto Iron Company's mine (see Pa., Franklin co.); Mount Bank (see Tenn., Blount co.); Mount Holly mine (see Pa., Cumberland co.); Mount Hope mines (see N. J., Morris co.); Mount Hope mine (see N. Y., Washington co); Mount Olive mine (see N. J., Morris co); Mount Pleasant mine (see N. J., Morris co.); Mount Savage mine (see Ky., Carter co.); Mount Torsey or Virginia mine (see Va., Augusta co.); Moxahala mine (see Ohio, Perry co.); Moyer's mine (see Pa., Lebanon co.); Muirkirk mine (see Md., Prince George co.); Mullen's (Charles) mine (see Pa., Cumberland co.); Mullen mine (see Pa., Cumberland co.); Munford mine (see Ga., Bartow co.); Mush's (B., G. & Co.) mine (see Pa., Perry co.); Myers mine (see Pa., Cumberland co.). **N.** Nail or Forshee mine (see N. Y., Orange co.); Nankwell's (Richard) mine (see Pa., Juniata co.); Napier's furnace mine (see Tenn., Lawrence co.); National mine (see Mich., Marquette co.); Naylor & Co.'s (No. 6½) mine (see Va., Amherst co.); Near Mountain mine (see Tenn., Johnson co.); Neighbour mine (see N. J., Hunterdon co.); Nelson Bush mine (see N. Y., Clinton co.); Nelson mine (see Mich., Marquette co.); Nelson mines (see N. C., Stokes co.); New Bed mine (see N. Y., Essex co.); Newcastle Coal and Iron Company's mine (see Ala., Jefferson co.); New Castle Station mine (see Ala., Jefferson co.); New Castle mine (see Pa., Lawrence co.); New Dorp mine (see N. Y., Richmond co.); New mine (see N. J., Warren co.); Neshannock mine (see Pa., Lawrence co.); Newman's (G. S.) mine (see Tenn., Sevier co.); New York Hematite mine (see Mich., Marquette co.); New York mine (see Mich., Marquette co.); Noble mine (see Va., Wythe co.); Nolan shaft (see N. Y., Essex co.); Norris or Whitaker mine (see Md., Baltimore co.); North Garden mine (see Va., Albemarle co.); Northwestern Iron Company's mine (see Wis., Dodge co.); Norton's mine (see N. Y., Oneida co.); Norway mine (see Mich., Menominee co.); Nova Scotia mine (see Mo., Dent co.); Nye mine (see Tenn., Dickson co.). **O.** Oakdale mine (see Tenn., Roane co.); Oak Springs mine (see Utah, Iron co.); O'Brien's (James) mine (see Md, Prince George co.); Odensoss (Jacob) mine (see Md., Baltimore co.); Ogden mines (see N. J., Sussex co.); Ogden's Corners (one mile southeast of) mine (see Pa, Tioga co.); Olcar mine (see W. Va., Mineral co.); Old Bank mine (see Va., Shenandoah co.); Old Bed mine (Witherbee, Sherman co.) (see N. Y., Essex co.); Old Carrick Furnace mine (see Pa., Franklin co.); Old Furnace mine (see N. J., Hunterdon co.); Old Maramec mine (see Mo., Phelps co.); Old Mill Creek furnace (see Tenn., Hickman co.); Old Mount Pleasant mine (see Pa., Franklin co.); Old Ogden mine (see N. J., Sussex co.); Old ore pit near Cahaba river (see Ala., Jefferson co.); Old Oxford mine (see Ala., Calhoun co.; Old Peach Orchard mine (see Pa., Cumberland co.); Old State furnace mine (see Ky., Bath co.); Old Southampton mine (see Pa., Franklin co.); Old Sterling mine (see N. Y., Jefferson co.) Oliphant Furnace mine (see Pa., Fayette co.); Olive (furnace) mine (see Ohio, Lawrence co.): O'Neil (or Forshee) mine (see under N. Y., Orange co.); Ontario Furnace Company's mine (see N. Y., Wayne co.); Orbiston mine (see Ohio, Athens co.); Orchard mine (see N. J., Morris co.); Oregon mine (see Md., Baltimore co.); Oregon (or Scott) mine (see N. Y., Orange co.); Ore Hill mine (see Conn., Litchfield co., Brookpit mine); Ore Hill mine (see N. C., Chatham co.); Orion mine (see Mich., Marquette co.); Ormond mine (see N. C., Gaston co.); Otter River mine (see Va., Campbell co.); Outlaw's (E. C.) mine (see Tenn, Stewart co.); Oxford Furnace mines (see N. J., Warren co.); Oxford mine (see Va., Campbell co.); Ozark mine (see Mo., Phelps co.) **P.** Paddy's Rest Creek mine (see Wis., Jackson co.); Palmer Hill mine (see N. Y., Clinton co.); Palmer mine (see Mich., Marquette co.); Panic or White Rock mine (see Va, Smyth co.); Pardee mine (see N. J., Sussex co.); Pass Orchard mine (see Pa., Franklin co.); Patterson mine (see Pa., Blair co.); Patton mine (see Oreg., Clackamas co.); Patty's mine (see Tenn., McMinn co.); Pawling mine (see N. Y., Dutchess co.); Peach Tree mine (see Ga., Bartow co.); Pea Ridge (Blaucet Bros.) mine (see Ky., Greenup co.); Peck mine (see Ga., Polk co.); Pedunk mine (see under N. Y., Washington co.); Peffer mine (see Pa., Cumberland co.); Pendill mine (see Mich., Marquette co.); Pennington mine (see Ga., Folk co.); Pennsylvania Furnace mine (see Ky., Greenup co.); Pepper mine (see N. C., Stokes co.); Pepper mine (see Pa., Cumberland co.); Perkins (or Saginaw) mine (see Mich., Menominee co.); Peters and Mowry mine (see Tenn., Knox co.); Peterman's (George) mine (see Pa., Perry co.); Peters' mine (see N. J., Passaic co.); Petty mine (see N. J., Hunterdon co.); Phillips mine (see Ga., Polk co.); Phœnix mine (see Pa., Berks co.): Piatts land (see Tenn., Roane co.); Pidcock mine (see N. J., Hunterdon co.); Pike's Peak (or Hill) mine

Iron-ore mines of the United States, etc.—Continued.

(see N. J., Sussex co.); Pilot Knob mine (see Mo., Iron co.); Pilot Mountain (Hyatt's) mine (see N. C., Surry co.); Pine Creek furnace mine (see Pa., Armstrong co.); Pine Grove mine (see Pa., Cumberland co.); Piney furnace mine (see Tenn., Dickson co.); Pinion mine (see Tenn., Lawrence co.); Pioneer Iron Company's mine (see Ala., Tuscaloosa co.); Pipe (Clark furnace) mine (see Tenn., Stewart co.); Pitney mine (see N. J., Morris co.); Pittsburgh and Lake Superior mine (see Mich., Marquette co.); Pittsfield Bethel mine (see Vermont, Rutland co.); Pittsford Granger mine (see Vermont, Rutland co.); Pittsville mine (see Va., Pittsylvania co.); Plantation mine (see S. C., York co.); Pochuck mine (see N. J., Sussex co.); Poison Branch mine (see N. C., Ashe co.); Pomeroy mine (see Mo., Dent co.); Pond mines Nos. 1 and 2 (see Pa., Franklin co.); Poorman's mine (see Colo., Saguache co.); Porter mine (see Connecticut, Litchfield co.); Poplar Branch mine (see N. C., Surry co.); Poplar Springs mine (see Tenn., Montgomery co.); Potter's (M. L.) mine (see Ala., Jefferson co.); Potter mine (see N. Y., Washington co.); Pott's shaft (see N. Y., Essex co.); Prairie River mine (see Minn., Itasca co.); Pratt (or Sackett) mine,, see N. Y., Putnam co.); Promise mine (Mont Alto Iron Company) (see Pa., Franklin co.); Prospect mine (see Colo., Saguache co.); Propst's (N.) mine (see N. C., Burke co.); Prosser mine (see Oreg., Clackamas co.); Pryer mine (see N. Y., Oneida co.); Puget Sound Iron Company's mine (see Brit. Col., Texada island); Puget Sound Iron Company's mine (see Wash., Jefferson co.); Putnam (or Gates) mine (see N. Y., Essex co.). **Q.** Queen of the West mine (see Utah, Utah co.); Queen's Station mine (see Tenn., Carter co.); Quiggleville mine (see Pa., Lycoming co.); Quinnesec mine (see Mich., Menominee co.). **R.** Raapp mine (see Pa., Cumberland co.); Race mine (see Tenn., Stewart co.); Radley mine (see N. J., Hunterdon co.); Ragon mine (see Tenn., James co.); Railroad mine (see Mo., Crawford co.); Railroad mine (see Pa., Franklin co.); Railroad mine (see Va., Campbell co.); Raines and Weaver mine (see Va., Rockingham co.); Raines mine (see Va., Rockingham co.); Ramsey's (Alexander) property (see Pa., Huntingdon co.); Ramsoms mine (see N. C., Watauga co.); Randall Hill mine (see N. J., Morris co.); Rankines mine (see Tenn., Johnson co.); Rapp mine (see N. J., Warren co.); Rathburn, Foster & Winchester's mine (see Ala., Etowah co.); Ravenscliffe mine (see Va., Wythe co.); Rays mine (see Ohio, Jackson co.); Ray's (Dr.) property (see Ala., Bibb co.); Razer's (Squire J. H.) mine (see Tenn., Blount co.); Rebecca mine (see Pa., Blair co.); Redback or Spruce Swamp mine (see N. Y., Orange co.); Red Bank mine (see Pa., Blair co.); Red Belt mine (see Va., Appomattox co.); Red mine (see S. C., Spartanburgh co.); Red mine (see Tenn., Dickson co.); Red mine (see Tenn., Wayne co.); Red Mountain mine (see Ala., Jefferson co.); Red Ore mine (see Pa., Blair co.); Red Shear mine (see Tenn., Carter co.); Reid mine (see Mo., Phelps co.); Republic mine (see Mich., Marquette co.); Retreat bank (see Va., Botetourt co.); Rever and Coster mine (see Md., Baltimore co.); Reynolds mine (see N. Y., Columbia co.); Reynolds, Ryne & Arnold mine (see Md., Anne Arundel co.); Richard's mine (see N. J., Morris co.); Rich Hill mine (see Va., Pulaski co.); Richlands mine (see N. C., Watauga co.); Richmond Furnace mine (see Pa., Franklin co.); Ridgley mine (see Md., Baltimore co.); Ridge mine (see Ala., Calhoun co.); Ridge Valley furnace mine (see Ga., Floyd co.); Riegel mine (see N. J., Warren co.); Riga mine (see N. Y., Dutchess co.); Rinesmith's mine (see Pa., Perry co.); Ringwood (Cannon, Peter, Hope & Hewitt) mines (see N. J., Passaic co.); Rising Fawn mine (see Ala., Etowah co.); Ritter's (J.) mine (see Pa., Lehigh co.); Riverside mine (see Mo., Dent co.); Robbin's Run mine (see Ky., Carter co.); Robert's, J. D.) mine (see Tenn., Roane co.); Roberts mine (see N. J., Sussex co.); Robeson Farm mine (see Pa., Blair co.); Robinson's (John) mine (see Pa., Juniata co.); Rockaway Valley mine (see N. J., Morris co.); Rock's (George) mine (see Pa., Franklin co.); Rocks' (Jacob) mine (see Pa., Franklin co.); Rocky Mount mine (see Va., Franklin co.); Rock ore mine (see Wis., Dodge co.); Rock Run furnace (see Ala., Cherokee co.); Rodenburg mine (see under N. J., Hunterdon co.); Rodgers' mine (see Ala., Jefferson co.); Rogers' mine (see N. C., Stokes co.); Rolling-Mill mine (see Mich., Marquette co.); Romig's (Reuben) mine (see Pa., Lehigh co.); Rose mine (see N. Y., Putnam co.); Rose Point mine (see Pa., Lawrence co.); Roseville mine (see N. J., Sussex co.); Rose mine (see Pa., Mifflin co.); Roth's (John) mine (see Pa., Lehigh co.); Rough and Ready furnace mine (see Tenn., Stewart co.); Round Mountain furnace (see Ala., Cherokee co.); Rowe's mine (see Pa., Berks co.); Rowland mine (see Mich., Marquette co.); Ruby (or Plaster) mine (see Pa., Franklin co.); Ruch & Brother's mine (see Pa., Lehigh co.); Ruth mine (see Pa., Franklin co.). **S.** Sackett mine (see N. Y., Putnam co.); Sadler (or Stack) mine (see Va., Alleghany co.); Saginaw mine (see Mich., Marquette co.); Saginaw mine (see Mich., Menominee co.); Saguache mine (see Colo., Saguache

Iron-ore mines of the United States, etc.—Continued.

co.); Sailor Boy mine (see Utah, Utah co.); Salisbury mine (see Mich., Marquette co.); Saint Clair or Busket mine (see Mo., Franklin co.); Salbne mine (see Pa., Clinton co.); Samson mine (see N. J., Morris co.); Sampson's (Cripple creek) mine (see Va., Wythe co.); Sandy Ridge mine (see Pa., Huntingdon co.); Sarah Furnace mine (see Pa., Blair co.); Sargent's (Tuscarawa Iron Works) mine (see N. C., Guilford co.); Sayers and Oglesby mine (see Va., Wythe co.); Schneider's (David) mine (see Pa., Lehigh co.); School-house mine (see Ky., Lyon co.); Scholl (J. D.) & Co.'s mine (see Pa., Lehigh co.); Schwartz's mine (see Pa., Lehigh co.); Scioto mine (see Ohio, Scioto co.); Scofield's mine (see under N. J., Morris co.); Scotia (No. 1) mine (see Mo., Crawford co.); Scott mine, (see N. J., Morris co.); Scott or Oregon mine (see N. Y., Orange co.); Scoville (or Chapin) mine (see Conn., Litchfield co.); Scrub Oak mine (see N. J., Morris co.); Seam's (Conrad) mine (see Pa., Lehigh co.); Seaton mine (see Tenn., Blount co.); "Second Vein" (east of "Old Furnace Vein") (see Va., Amherst co.); Section Six mine (see N. C., Cherokee co.); Section Twelve mine (see Mich., Marquette co.); Semi-Magnetic mine (see Va., Wythe co.); Sevier's (Dr.) mine (see Ala., Franklin co.); Shade's (Dr. J. A.) mines (see Pa., Huntingdon co.); Shaefer mine (see Pa., Berks co.); Shamblin and Dickey mine) (see Ala., Tuscaloosa co.); Shankweller mine (see Pa., Lehigh co.); Sharp mine (see Tenn., Sullivan co.); Shawnee Furnace mine (see Ohio, Perry co.); Sheirer's mine (see Pa., Lehigh co.); Shelby Coal Company's mine (see Ala., Tuscaloosa co.); Shelby Iron Company's mine (see Ala., Shelby co.); Shepherd's mine (see Ky., Lawrence co.); Shepherd Mountain mine (see Mo., Iron co.); Sheridan mine (see Tenn., Stewart co.); Sherman mine (see Mass., Berkshire co.); Shields mine (see N. J., Warren co.): Shirtleff mine (see N. Y., Jefferson co.); Shopp mine (see Pa., Cumberland co.); Short Mountain mines (see Pa., Blair co.); Sickles mine (see N. J., Sussex co.); Side mine (see Ala., Talladega co.); Sieger's (Samuel) mine (see Pa., Lehigh co.); Silverhorn mine (see under N. J., Hunterdon co.); Silver Mountain mine (see S. C., York co.); Simmon's Mountain mine (see Mo., Dent Co.); Skaggs (George L.) mine (see Md., Prince George co.); Skellenger Farm mine (see N. J., Morris co.); Skinner mine (see Ala., Calhoun co.); Sligo Furnace mine (see Pa., Clarion co.); Sligo Furnace mine (see Mo., Dent Co.); Slippery Gutmine (see Va., Amherst co.); Small's (John) mine (see Pa., Franklin co.); Smith's (A. G.) mine (see Ohio, Columbiana co.); Smith, Duncan, and Avery's mine (see Pa., Franklin co.); Smithgrove (southeast of) mine (see Pa., Snyder co.); Smith (Jacob) mine (see Md., Baltimore co.); Smith's (J. and D.) mine (see Pa., Lehigh co.); Smith-McAlister mine (see Va., Alleghany co.); Smith's (Major W. R.) mine (see Tenn., Cocke co.); Smith mine (see N. C., Chatham co.); Smith mine (see Tenn., Bradley co.); Smith mine (see N. Y., Essex co.); Smyer's (D. H.) heirs' mine (see Pa., Berks co.); Snake Creek Gap mine (see Ga., corner of Gordon, Walker, and Whitfield cos.); Snake Pond mine (see Ga., Polk co.); Soister mine (see Pa., Blair co.); Solomon's mine (see Tenn., Roane co.); Songa Hollow (Brown's forge) mine (see Tenn., Johnson co.); South Cross mine (see Utah, Iron co.); South Jackson mine (see Mich., Marquette co.); "Southern States' Coal, Iron, and Land Company's" Wolf creek mine (see Tenn., Cocke co.); Sparks mine (see Ala., Talladega co.); Specular mine (see Tenn., Carter co.); Speedwell mine (see Va., Wythe co.); Spengler mine (see Va., Botetourt co.); Splitrock Pond mine (see N. J., Morris co.); Springfield mine (see Md., Carroll co.); Springfield mines (see Pa., Blair co.); Springfield (Southern Railroad Company) mine (see Ohio, Jackson co.); Spring Hill or Wadsworth mine (see W. Va., Monongalia co.); Spruce Swamp (or Redback) mine (see N. Y., Orange co.); Spurr Mountain mine (see Mich., Baraga co.); Stambach's (William) mine (see Pa., Huntingdon co.); Stanfield's (Lewis) mine (see Tenn., Scott co.); Stanhope (or Hude) mine (see N. J., Sussex co.); Staley mine (see N. J., Warren co.); Staunton mine (see Mo., Franklin co.); Steel's mine (see Tenn., Montgomery co.); Stein's (Henry) mine (see Pa., Lehigh co.); Steininger's (Jacob) mine (see Pa., Lehigh co.); Stephens mine (see Ga., Bartow co.); Stephens mine (see Tenn., Greene co.); Stephenson mine (see Mich., Menominee co.); Steven's mine (see N. Y., Orange co.); Sterling mine (see Mich., Marquette co.); Sterling mine (see N. J., Morris co.); Sterling mine (see N. Y., Orange co.); Steven's mine (see N. Y., Rockland co.); Steward mine (see Mich., Marquette co.); Stewardson Furnace mine (see Pa., Armstrong co.); Stewart (Robbin's Run) mine (see Tenn., Carter co.); Stickney Iron Company's mine (see Md., Baltimore co.); Stimson mine (see Mo., Phelps co.); Stinger's (Squire) mine (see Pa., Franklin co.); Stone Dye mine (see Tenn., McMinn co.); Stonewall mine (see Va., Appomattox co); Stonewall mine (see Ala., Cherokee co.); Stony Brook (or Pike's Peak) mine (see N. J., Sussex co.,); Stouffer's (Jacob) mine (see Pa., Franklin co.); Stoutenburgh mine (see N. J., Morris co.); Stout's

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mine (see Tenn., Johnson co.); Strickland mine (see Ala., Bibb co.); Strickler mine (see Pa., Cumberland co.); Strickler's mine (see Pa., Lebanon co.); Stuart or Sunk mine (see N. Y., Putnam co.); Styles mine (see N. Y., Morris co.); Sulphur Hill mine (see N. J., Sussex co.); Summit (or Tip Top) mine (see N. Y., Orange co.); Sunk mine (see N. Y., Putnam co.); Swaringen (farm) mine (see Ohio, Jackson co.); Swartz & Fogel's mine (see Pa., Lehigh co.); Swatara mine (see Pa., Dauphin co.); Swayze mine (see N. J., Warren co.); Swengle and Dunning mine (see Pa., Snyder co.); Sylvan Lake mine (see N. Y., Dutchess co.). **T.** Talbot mine (see Md., Baltimore co.); Talladega mine (see Ala., Talladega co.); Tatham Brothers mine (see Pa., Berks co.); Taylor's (Isaac) mine (see Pa., Huntingdon co.); Taylor mine (see Mich., Marquette co.); Taylor mine (see N. Y., Orange co.); Taylor mine (see Tenn., Carter co.); Taylor's mine (see Tenn., Johnson co.); Teabo mine (see N. J., Morris co.); Tecumseh furnace mine (see Ala., Cherokee co.); Tefft mine (see N. Y., Essex co.); Tellico mine (see Tenn., Monroe co.); Terry mine (see Ala., Cherokee co.); Theall & McCollum mines (see N. Y., Putnam co.); Thomas Iron Company's mines (see Pa., Lehigh co.); Thomas mine (see Md., Frederick co.); Thomas mine (see Mo., Dent co.); Thomas (or Shields) mine (see N. J., Warren co.); Thompson mine (see Pa., Blair co.); Three Top Mountain mine (see Va., Shenandoah co.); Tilly Foster mine (see N. Y., Putnam co.); Tip Top (or Summit) mine (see N. Y., Orange co.); Todd mine (see N. Y., Putnam co.); Tollis' (John) mine (see N. Y., Richmond co.); Tomotla mine (see N. C., Cherokee co.); Tompkins mine (see Tenn., Johnson co.); Topping mine (see N. J., Morris co.); Tower's Spring mine (see N. Y., Dutchess co.); Towle mine (see N. Y., Richmond co.); Treadaway mine (see Ala., Cherokee co.); Tremblay's mine (see N. Y., Clinton co.); Trexler's (E. H.) mine (see Pa., Berks co.); Trexler & Kline's mine (see Pa., Lehigh co.); Trice mine (see Va., Alleghany co.); Trigg Furnace mine (see Ky., Trigg co.); Turkey Hill, or West End mine (see N. J., Hunterdon co.); Tuscaloosa Iron Company's mine (see Ala., Tuscaloosa co.); Two River Range mine (see Minn., Saint Louis co.); Tyson's Four Corners mine (see N. Y., Richmond co.); Tyson Furnace mine (see Vt., Windsor co.). **U.** Udree mine (see Pa., Berks co.; Union mine (see N. Mex., Santa Aña co.); Union Furnace Company's mine (see Pa., Union co.); Upper mine (see Ala., Cherokee co.); Upper or Mansfield mine (see Pa., Tioga co.); Upper Wood (or De Camp) mine (see Hibernia mines, N. J., Morris co.). **V.** Valley Pond mine (see N. Y., Dutchess co.); Van's Land mine (see Ala., Jefferson co.); Van Syckles (or Church) mine (see N. J., Hunterdon co.); Varner mine (see Tenn., Greene co.); Vernon Furnace mine (see Tenn., Montgomery co.); Vermilion Range mines (see Minn., Saint Louis co.); Vernon mine (see Ala., Lamar co.); Vernon mines (see Pa., Fayette co.); Verplanck Point mine (see N. Y., Westchester co.); Vineyard mine (see Tenn., Hamblen co.); Vulcan mine (see Mich., Menominee co.); Vulcan mine (see Utah, Beaver co.); Vulcan mine (see Utah, Weber co.). **W.** Wah-Wah mine (see Bowens mine, see Utah, Weaver co.); Walsenburg mine (see Colo., Huerfano co.); Walton mine (see Va., Wythe co.); Wanderer mine (see Utah, Iron co.); War Eagle mine (see Utah, Iron co.); Warwick mine (see N. Y., Orange co.); Warwick mine (see Pa., Berks co.); Washer mine (see Ala., Calhoun co.); Washer mine (see Pa., Perry co.); Washington Forge mine (see N. J., Morris co.); Washington Furnace mine (see Ohio, Lawrence co.); Washington mine (see N. J., Warren co.); Wash Place mine (see Tenn., Johnson co.); Watkins mine (see Mo., Dent co.); Wawayanda mine (see N. J., Sussex co.); Wayne Furnace mine (see Tenn., Wayne co.); Wean mine (see N, J., Hunterdon co.); Weaver's (Benjamin) mine (see Pa., Lehigh co.); Weaver mine (see Pa., Cumberland co.); Webster (Smith, Duncan and Avery) mine (see Pa., Franklin co.); Weed mine (see N. Y., Columbia co.); Weiler (Dankle) mine (see Pa., Berks co.): Weinman's (George) mine (see Pa., Franklin co.); Welsh mine (see N. J., Warren co.); Welcker's (B. F.) property (see Tenn., Roane co.); Weldon mine (see N. J., Morris co.); Welling mine (see N. J., Sussex co.); Wells mine (see N. Y., Oneida co.); Welsh shaft (see N. Y., Essex co.); Werner & Reinhart's mine (see Pa., Lehigh co.); West bank (see Va., Shenandoah co.); West Bellwood mine (see Tenn., Stewart co.); West End (or Turkey Hill) mine, N. J., Hunterdon co.); West Point furnace (see N. 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mine (see Tenn., Hamblen co.); Willis mine (see N. J., Morris co.); Will's mine (see Va., Alleghany co.); Wilson's Mill mine (see N. C., Johnson co.); Wilson mine (see Tenn., Blount co.); Winthrop mine (see Mich., Marquette co.); Winkler's mine (see Ohio, Tuscarawas co.); Wolf Creek mine (see Tenn., Cocke co.); Woodall mine (see Ala., Saint Clair co.); Woods mine (see Ga., Bartow co.); Woods mine (see Ga., Polk co.); (see Md., Baltimore co.); Wood's (property) mine (see Va., Botetourt co.); Wood's (Sterret) mine (see Pa., Cumberland co.); Woodward (S. H.) mine (see Ala., Tuscaloosa co.); Worley furnace (see Tenn., Dickson co.); Wright or Budd mine (see N. J., Sussex co.); Wyan (farm) mine (see Ohio, Tuscarawas co.). Y. Yellow Ridge mines (see N. C., Gaston co.); Yingst's mine (see Pa., Lebanon co.); Yokel's (George) mine (see Md., Prince George co.); Young's (J.) mine (see Pa., Lycoming co.). Z. Ziegler's (David) mine (see Pa., Berks co.); Ziegler's (Jonathan) mine (see Pa., Berks co.); Ziegler's mine (see Pa., Lawrence co.); Zane mine (see Mo., Crawford co.); Zoar (near) mine (see Ohio, Tuscarawas co.).

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Cherokee county. Coal (bituminous), statistics of the production of, in, c. y. (650–653); lead and zinc ore, statistics of the production of, in c. y. (804–805).
Cloud county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Coffey county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Crawford county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Douglass county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Franklin county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Greenwood county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Jefferson county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Labette county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Leavenworth county. Coal (bituminous), statistics of the production of, in c. y. (650-653).
Linn county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Montgomery county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
Nemaha county. Coal (bituminous), statistics of the production of, in c. y. (650–653).
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Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).
Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 e); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 a); amount of each kind of ore mined in each county in the c. y. (23 f); amount of each kind and grade of ore, according to its contents of iron, produced, in c. y. (27 f); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in c. y. (29 d, 30 a); royalty paid on each kind of ore mined in c. y. (32 c).
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Bell county. Coal (bituminous), statistics of the production of, in the c. y. (654–657).
Boyd county. Coal (bituminous), statistics of the production of, in c. y. (654–657). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of, in c. y. (40–43).
Breathitt county. Coal (bituminous), statistics of the production of, in c. y. (654–657).
Butler county. Coal (bituminous), statistics of the production of, in c. y. (654–657).
Caldwell county. Coal (bituminous), statistics of the production of, in c. y. (654–657).
Carter county. Coal (bituminous), statistics of the production of, in c. y. (654–657). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 e); statistics of the production of, in c. y. (40–43). Iron-ore mines: Bay's mine; section; L.; one sample: Fe,P. (299 c, 544 c); Duzan's (S. S.) mine; section; C.; one sample; Fe,P. (296 c, 544 b); Furgerson mine (Iron Hill furnace); section; C.; one sample: Fe,P. (297 f, 544 c); Iron Hill property (see Furgerson mine) (297 f, 544 c); Lambert mine; section; C.; three samples: Fe,P. (296 f, 297 a, 544 c); Mount Savage mines; C.; one sample; Fe,P. (299 b, 544 c); Robbin's Run (or Stewart) mine; section; L. and C.; five samples: Fe,P. (298 b, 544 c); Stewart's mine (see Robbin's Run mine) (298 b, 544 c).
Clay county. Coal (bituminous), statistics of the production of, in c. y. (654–657).
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Daviess county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Edmonson county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Elliott county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Estill county. Coal (bituminous), statistics of the production of, in c. y. (654–657). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of, in c. y. (40–43). Iron-ore mines: Estill Furnace bank; C.; one sample; Fe,P. (293 b, 542 f).

Floyd county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Garrett county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Grayson county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Greenup county. Coal (bituminous), statistics of the production of, in c. y, (654–657). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Blancet mine; (see Pea Ridge mine); Hunnewell furnace mines; C.; two samples: Fe,P. (296 a, 544 b). Pea Ridge mine (Blancet Bros.); section; C.; one sample: Fe,P (295 b, 544 b). Pennsylvania furnace mines; L. and C., 5 samples: Fe,P. (295 c, 544 a); Reuben's mine; section; two samples: Fe,P. (294 f, 544 a). Turkey Lick mine (see Hunnewell furnace mines).

Hancock county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Harlan county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Henderson county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Hopkins county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Jackson county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Johnson county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Knox county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Laurel county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Lawrence county. Coal (bituminous), statistics of the production of, in c. y. (654–657). Iron-ore mines: Shepherd's mine; section; L.; one sample; c.; one sample, Fe,P. (299 f, 300 a, 544 b, 586).

Lee county. Coal (bituminous), statistics of the production of, in c. y, (654–657),

Letcher county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Lyon county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Center Bank (No. 2); L.; one sample: Fe,P. (290 d, 542 f). Fulton mine; L.; one sample: Fe,P. (289 f, 542 f); School-house mine, near Center furnace; sections; L.; one sample: Fe,P. (289 f, 542 f).

Madison county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Magoffin county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Martin county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

McLean county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Menifee county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Montgomery county. Coal (bituminous), statistics of the production of, in c. y. (654–657)

Morgan county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Muhlenburgh county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Ohio county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Owsley county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Perry county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Pike county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

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Powell county. Coal (bituminous), statistics of the production of, in c. y. (654–657). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Anderson mine (Estill furnace); section; C.; two samples: Fe,P. (292 e, 542 f).

Pulaski county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Rockcastle county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Rowan county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Trigg county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (23 f); statistics of the production of iron ore in c. y. (40–43). Iron-ore mines: Trigg furnace mine; L.; one sample: Fe,P. (290 e, 542 f).

Union county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Wayne county. Coal (bituminous), statistics of the production of, in c. y. (654–457).

Webster county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

Whitley county. Coal (bituminous), statistics of the production of, in c. y. (654–657).

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Kerr, W. C., assigns Danbury schists in North Carolina to Upper Laurentian (7 a).

Killibrew, J. B. Map by, showing relations of ore-beds sampled in Campbell, Scott, and Anderson counties, Tenn. (348, 349 c).

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Lead ore. Percentage of, worked up by the various processes (818 b); consumed, relation of product to, by regions and processes (820); consumed, relation of product to, by states (820); statistics of the production east of the 100th meridian, by counties, in c. y. (804–805); statistics of the production east of the 100th meridian, by states, in c. y. (806).

Lesley, Prof. J. P. On great fault in fossil ores of Elk Fork valley, Tennessee (349 c); on the geological position of the Pennsylvania magnetites (11 e); state geologist, second geological survey of Pennsylvania, permission to reprint analyses (179 c).

Lignite. Conversion of, into fuel of high heating power (791–796).

Limonite. Amount mined in the c. y., and its per cent. of the total ore product (21 a); amount mined in each geological horizon in each state in the c. y. (21 b); amount mined in each geological horizon in the United States in the c. y. (22 c); amount mined in each state in the c. y. (23 a); amount mined in each ore-producing county in the c. y. (23–26); carrying under 40 per cent. iron, amount produced in each state in c. y. (27 f, 28); carrying under 40 per cent. iron, amount produced in the United States in the c. y. (26 e); carrying 40 to 50 per cent. iron, amount produced in each state in c. y. (27 f, 28); carrying 40 to 50 per cent. iron, amount produced in the United States in the c. y. (26 e); carrying over 50 per cent. iron, amount produced in each state in c. y. (27 f, 28); carrying over 50 per cent. iron, amount produced in the United States in the c. y. (26 e); total amount of iron in ore containing under 40 per cent. iron (26 e, 27); total amount of iron in ore containing 40 to 50 per cent. iron (26 e, 27); total amount of iron in ore containing over 50 per cent. iron (26 e, 27); amount of iron in the different grades of ore mined in each state in the c. y. (28 e); amount of each grade, according to phosphorus-iron ratio, mined in the United States in the c. y. (29 f); amount of each grade according to phosphorus-iron ratio mined in each state in the c. y. (29 d); amount produced in the United States in c. y. with a phosphorus ratio under 0.05 (31 d); amount produced in the United States in c. y. with a phosphorus ratio greater than 1.00 (31 e, 32 b); amount of royalty paid on, in each state in the c. y. (32 d); mined in the Lake Superior region in the c. y., classified according to its contents in metallic iron (9).

Bessemer ore. Amount mined in each state in the c. y. (30 e); amount mined in the United States in the c. y., and its per cent. of total Bessemer ore product (31 b).

Limonite of the Siluro-Cambrian limestones and schists (10 c); forms of (10 d); origin of (10 f); deposits of the Lower Silurian, yield of, in 1880 (11 d); Oriskany, character and position of the (15 a); residuary, occurrence of, in Kentucky and Tennessee (15 c).

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Magnetite. Amount mined in the c. y., and its per cent. of the total ore product (21 a); amount mined in each geological horizon in each state in the c. y. (21 b); amount mined in each geological horizon in the United States in the c. y. (22 c); amount mined in each state in the c. y. (23 a); amount mined in each ore-producing county in the c. y. (23–26); carrying under 45 per cent. iron, amount produced in the United States in the c. y. (26 d); carrying 45 to 60 per cent. iron, amount produced in the United States in the c. y. (26 e); carrying over 60 per cent. iron, amount produced in the United States in the c. y. (26 e); total amount of iron in ore containing under 45 per cent. iron (26 e, 27); total amount of iron in ore containing 45 to 60 per cent. iron (26 e, 27); total amount of iron in ore containing over 60 per cent. iron (26 e, 27); carrying under 45 per cent. iron, amount produced in each state in c. y. (27 f, 28); carrying 45 to 60 per cent. iron, amount produced in each state in c. y. (27 f, 28 a); carrying over 60 per cent. iron, amount produced in each state in c. y. (27 f, 28); amount of iron in the different grades of ore mined in each state in the c. y. (28 e); amount of each grade, according to phosphorus iron ratio, mined in each state in the c. y. (29 d); amount of each grade, according to phosphorus iron ratio, mined in the United States in the c. y. (29 f); amount produced in the United States in c. y. with a phosphorus ratio greater than 1.00 (31 d, 32 b); amount produced in United States in c. y. with a phosphorus ratio under 0.05 (31 d); amount of royalty paid on, in each state, in the c. y. (32 d); in the Lake Superior region in the census year, classified according to its contents in metallic iron (8); of the Mesozoic sandstone in Pennsylvania, product of, in 1880 (12 a).

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MAINE.

Copper. Statistics of the production of, in c. y. (798, 799).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States' iron-ore product (19 e); amount of iron in the different kinds and grades of ore mined in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 e).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 d); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 a); amount of each kind of ore mined in each county in c. y. (24 a); amount of each kind and grade of ore, according to its contents of iron, produced in c. y. (27 f); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in c. y. (29 d, 30 b).

Iron ore. Bessemer, amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e).

Iron ore. Statistics of the production of iron ore in c. y. (44–47, 64–69); general average of these statistics (70, 71).

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Hancock county. Copper ore, statistics of the production of, in c. y. (798, 799).

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Piscataquis county. Iron ore: Amount of each kind of iron ore mined in the c. y. (24 a); statistics of the production of iron ore in, in c. y. (44–47). Iron ore mines: Katahdin; L.; three samples: Fe, P. in two; one c. (79 b, 544 d).

Manganese ore in Georgia (379–382); in Tennessee (336 a, 339 d); statistics of the production of, by states and counties (842): by states (850–851).

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Asbestos. Statistics of the production of, in c. y. (839, 846–847).

Coal (bituminous), statistics of the production of, in c. y. (658–661, 674–675).

Chromic iron. Statistics of the production of, in c. y. (839, 846–847).

Copper. Statistics of the production of, in c. y. (798–799).

Glass-sand. Statistics of the production of, in c. y. (840, 848–849).

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Hydraulic cement. Statistics of the production of, in c. y. (841, 848–849).

Infusorial earth. Statistics of the production of, in c. y. (841, 848–849).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States' iron-ore product (19 e); amount of iron in the different kinds and grades of ore mined in, in c. y. (28 e); average per cent. of iron mined in c. y. (19 e).

Iron ore. Order of the state according to the amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 e); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 a); amount of each kind of ore mined in each county in the c. y. (24 b); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (27 f); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in, in c. y. (29 d, 30 b).

Iron ore. Statistics of the production of, in c. y. (44–47, 64–69); general averages of these statistics (70–71).

Iron ore, partial analyses of (544 to 547).

Iron ores. Notes on the samples of iron ore collected in, by Edward R. Benton (245–260); MESOZOIC ores (carbonates and derivatives) (245); *map* of eastern Maryland, showing location of iron-ore banks sampled (245); Baltimore county (245); Prince George county (248 e): ores from OTHER HORIZONS than the Mesozoic; Baltimore county: Limonite (254 f); Carroll county: Limonite (257 d); magnetite (257 e); Frederick county: Limonite (258 b); fossil (260 a).

Kaolin. Statistics of the production of, in c. y. (842, 848, 849).

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Quartz and feldspar. Statistics of the production of, in c. y. (844, 852, 853).

Soapstone. Statistics of the production of, in c. y. (845, 852, 853).

Alleghany county. Coal (bituminous), statistics of the production of, in c. y. (658–661). Hydraulic cement, statistics of the production of, in c. y. (841). Iron ore, amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Iron ore mines: Bowery mine; L.; ore sample: Fe,P. (259 e, 246 d); Frost mine, F.; one sample: Fe,P.,P. (260 a, 546 d).

Anne Arundel county. Glass-sand: Statistics of the production of, in c. y. (840). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 a). Iron ore: Statistics of the production of, in, in cy. (44–47). Iron-ore mines: Howard Brown's mine (see Mitchell, Wilson, and Riley) (251 f, 246 c); Linthicum (A. S.) mine, H and C; two samples: Fe,P. (251 c, 546 b); Mitchell, Wilson and Riley's (Howard Brown) mine; section; C.; two samples: Fe,P. (251 f, 252 a, 546 c); Reynolds, Kyne, and Arnold mine; section; C.; two samples: Fe,P. (253 a, 546 c).

Baltimore county. Asbestos, statistics of the production of, in c. y. ((839); Chromic iron, statistics of the production of, in c. y. (839). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of, in c. y. (44–47). Soapstone, statistics of the production of, in c. y. (845). Iron-ore mines: Bower's Spring Garden; C.; one sample: Fe,P. (544 e); Furstenburg's Furnace mine (Stemmer's run); C.; four samples: Fe,P. (247 f, 248 a, 544 e); Furstenburg mine; section; C.; one sample: Fe,P. (246 d, 247 c, 544 e); Green Spring mine; L.; one sample: Fe,P. (257 b, 546 a); Hegeman or Smith mine; C.; with H. and L.; one sample: Fe,P.,P, in Fe (247 a, 246 b, 544 e); Kelley mine; section; L.; one sample: Fe,P. (255 e, 544 f); Maryland or Ellicott's mine; C.; with H. and L.; two samples: Fe,P. (254 d, 544 f); Norris or Whitaker mine; H. with C.; one sample: Fe,P.,P, in Fe (253 e, 544 f); Odensoss (Jacob); section; C.; one sample: Fe,P. (252 f, 253 d, 544 f); Oregon mine; section; L.; two samples: Fe,P. (256 a, 257 a, 546 a); Rever and Koster mine; section; sketch of ore nodules; C.; with H. and L.; one sample: Fe,P. (246 d, 247 e, 544 e); Ridgeley mine; L.; one sample: Fe,P. (254 f, 544 f); Smith's (Jacob) mine; section; C.; with H. and L.; one sample: Fe,P. (245 b, 544 e); Stickney (Iron Company) mine; C.; H. with L.; two samples: Fe,P. (254 a, 644 f); Talbot mine; L.; one sample: Fe,P. (255 d, 544 f); Woods mine; L.: one sample: Fe,P. (255 a, 544 f).

Calvert county. Infusorial earth, statistics of the production of, in c. y. (841).

Carroll county. Copper, statistics of the production of, in c. y. (798, 799). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Iron-ore mines: Avon dale mine; L.; one sample: Fe,P. (257 d, 546 c); Springfield mine; M.; two samples: Fe,P. (257 e, 258 a, 546 c).

Cecil county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Kaolin, statistics of the production of, in c. y. (842). Quartz and feldspar, statistics of the production of, in c. y. (844).

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Frederick county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Iron-ore mines: Catoctin or Kunkel mine; L.; two samples: Fe,P. (258 f, 259 a, 546 d); Ensor mine; section; L.; two samples: Fe,P. (258 b, 546 c); Grim's mine; L.; one sample: Fe,P. (259 b, 546 d); Thomas mine; L.; one sample: Fe,P. (259 d, 546 d). Lead and zinc, statistics of the production of, in c. y. (804, 805, 806).

Harford county. Asbestos, statistics of the production of, in c. y. (839). Chromic iron, statistics of the production of, in c. y. (839). Iron ore: Amount of each kind of iron ore mined in the c. y. (24 b); statistics of the production of, in c. y. (44–47). Quartz and feldspar, statistics of the production of, in c. y. (844).

Howard county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Iron-ore mines: Hanover Switch mine; C.; two samples: Fe,P. (544 e).

Montgomery county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47).

Prince George's county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47). Iron-ore mines: Friel & Milbrook mine; section; H.; two samples: Fe,P. (250 d, 546 b); Muirkirk mine; C.; with H. and L.; two samples; Fe,P. (250 b, 546 b); O'Brien (James) mine; section; H.; a little C.; one sample: Fe,P. (251 a, 546 b); Skaggs (George L.) mine; section; C.; with H. and L.; one sample: Fe,P. (248 e, 546 b); Yokel (George) mine; C. and H; one sample: Fe,P. (248 f, 546 b).

Washington county. Hydraulic cement, statistics of the production of, in c. y. (841). Iron ore: Amount of each kind of iron ore mined in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (44–47).

MASSACHUSETTS.

Corundum (emery). Statistics of the production of, in c. y. (840, 846–847).

Glass-sand. Statistics of the production of, in, in c. y. (840, 848, 849).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States' iron-ore product (19 d); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 d).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 d); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of amount and value of the United States' product (19 d, 74 e); average value per ton (19 d); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (24 c); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 a); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in, in c. y. (29 d, 30 b); royalty paid on each kind of ore mined in, in c. y. (32 c).

Iron ore. Statistics of the production of iron ore in c. y. (44–47, 64–69); general averages of these statistics (70, 71).

Iron ores. Partial analyses of (541–547).

Iron ores. Notes on the samples of iron ore in, collected by Bayard F. Putnam (86–87); general remarks on the (86 c); map showing location of iron mines east of the Hudson river (128).

Mica. Statistics of the production of, in c. y. (843, 850–851).

Nickel. Statistics of the production of, in c. y. (843, 850–851).

Quartz and feldspar. Statistics of the production of, in c. y. (844, 852–853).

Berkshire county. Glass sand, statistics of the production of, in c. y. (840). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); statistics of the production of iron ore in c. y. (44–47). Iron-ore mines: Bacon mine, L.; two samples: Fe,P. (87 f, 546 e). Bank mine; L.; two samples: Fe,P. (87 d, 546 e). Chauncey Leet mine; L.; one sample: Fe,P. (86 d, 546 e). Cheever mine; L.; two samples: Fe,P. (87 b, 546 e). Cone mine; L.; one sample: Fe,P. (87 a, 546 e). Cone mine described (87 a). Goodrich mine; L.; two samples: Fe,P. (86 f, 546 e). Nathaniel Leet mine; L.; one sample: Fe,P. (86 e, 546 e). Mason and Bliss mine mentioned (87 f). Sherman mine mentioned (87 f).

Hampden county. Corundum, statistics of the production of, in c. y. (840). Mica, statistics of the production of, in c. y. (843). Quartz and feldspar, statistics of the production of, in c. y. (844).

Middlesex. Nickel, statistics of the production of, in c. y. (843).

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Medina Formation, limonite ores of, in Pa. (198 d).

Metallurgical establishments and mines east of the 100th meridian, directory of (854).

Metals, consumption of, in manufactures (828).

Mesozoic [see also in Montana, under Jurassic and Cretaceous]; amount of carbonates and derivatives mined in each state in the c. y. (21 b); amount of iron ore mined in the United States in the c. y. (22 c); carbonates and derivatives of Maryland (245–254); sandstone of Pennsylvania, magnetite ores associated with (223–234).

Mica mines of New England, by N. S. Shaler (832–836).

Mica, statistics of the production of, by states and counties (843); by states (850, 851).

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Coal (bituminous), statistics of the production of, in c. y. (658–661, 674, 675).

Copper, statistics of the production of, in c. y. (798, 799).

Hydraulic cement, statistics of the production of, in c. y. (841, 848, 849).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States' iron-ore product (19 e); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 e).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 e); relation of the product to the area of iron-ore fields in (18 e); tonnage and value of high-grade ores in (20 b); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (24 c); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 a); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 d, 30 b); royalty paid on each kind of ore mined in, in c. y. (32 c).

Iron ore. Bessemer, amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e); proportion of Bessemer ore produced in (31 a); product of Bessemer ore in (9 b).

Iron ore. Statistics of the production of iron ore in c. y. (44–47, 64–69); general average of these statistics (70, 71).

Iron ores. Complete analyses of (586–591); partial analyses of (530–535).

Iron ores. Notes on the samples of iron ore collected in Michigan and northern Wisconsin, by Bayard T. Putnam (421–455); *map* (geological) of parts of Michigan and Wisconsin, showing position of belts of iron ore (421); Marquette iron region, *map* of (422); mines producing ore of Class I (hard specular) (424); mines producing ore of Class II (magnetic and slate) (428); mines producing ore of Class III (soft hematite); Negaunee range (432); Teal Lake range (434); Salisbury range (434); mines producing ore of Class IV (flag ore) (436); Menominee iron region (437); *map* of the Menominee iron region (438); Wisconsin (453).

Quartz and feldspar. Statistics of the production of, in c. y. (844, 852, 853).

Baraga county. Iron mines: Spurr Mountain mine; M.; one sample: Fe, P, S, Al, Mn, SiO_2 (431 a, 530 f).

Marquette county. Iron ore: Amount of each kind of ore mined in, in c. y. (24 c); statistics of the production of iron ore in, in c. y. (44–47); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a). Iron-ore mines: Baraga mine; H.; not sampled (432 c). Barnum mine; H. (s); one sample: Fe, P, S, Si, Al, Mn, Ti, Si (426 f, 530 c). Bessemer mine; H.; one sample: Fe, P, S, Si, Al, Mn (434 d, 532 c). Boston mine; H. (s); one sample: c (428 b, 530 d, 587). Cambria mine; H.; one sample: Fe, P, S, Si, Al (434 c, 532 c). Carr mine; H.; not sampled (436 d). Champion mine; product of iron ore in c. y. and its value and the number of employés (75 d); M. and H. (s); four samples: Fe, P, S, Al, Mn, Ti, Si (429 b, 530 d). Cheshire mine; H.; one sample: Fe, P, S, Si, Al, Mn (437 a, 532 e). Chicago mine; H.; not sampled (432 f). Cleveland Iron Mining Company's mine; product of iron ore in c. y. and its value and the number of employés (75 d); H. (s); two samples: Fe, P, S, Si, Al, Mn, Ti, Si (425 a, 530 a). Colum-

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Marquette county—Continued.
bia mine; H. (s); not sampled (432 c). Dalliba mine; H. (s); not sampled (428 d); Edwards mine; M. and H. (s); two samples: Fe, P, S, Si, Al, Mn, Ti, Si (428 f, 429 a 1530 d). Excelsior mine; H. (s); not sampled (428 a). Forest City mine; H.; not sampled (434 e). Foster mine; H.; not sampled (435 a). Goodrich mine; H. (s); not sampled (428 a). Gribben mine; H.; not sampled (436 d). Humboldt mine; M. and H. (s); one sample: Fe, P, S, Si, Al, Mn, Si (428 f, 530 d). Indiana mine; H.; not sampled (432 d). Jackson mine; product of iron ore in c. y., and its value and the number of employés (75 d); H. (s); two samples: Fe, P, S, Si, Al, Mn, Ti, Si (424 f, 530 a). Keystone mine; M. and H. (s); one sample: C.; one sample: S, P, Fe, Al, Ti, Si (429 e, 530 e). Lake Angeline mine; H. (s); four samples: Fe, P., S, Si, Al, Mn, Ti (427 a, 530 c). Lake Superior hematite mine; H.; one sample: Fe, P, S, Mn, Si (435 f, 532 d). Lake Superior iron mine; product of iron ore in c. y., and its value and the number of employés (75 d); H. (s); four samples: Fe, P, S, Si, Al, Mn, Ti, Si, P. (426 a, 530 b). Lowthian mine; H.; one sample: Fe, P, S, Si, Al, Mn (436 c, 532 d). Manganese mine; H.; one sample: Fe, P, Si, Al (433 a, 532 b). McComber mine; H.; two samples: c.; two samples: S, P, Fe, Si, Al, Mn (433 c, 532 b, 589). Michigamme mine; product of iron ore in c. y., and its value and the number of employés (75 d); M.; two samples: c.; four samples: Fe, P, S, Al, Mn, Si (430 a, 530 e, 586, 587). Milwaukee mine; H.; not sampled (433 b). Mitchell mine; H.; not sampled (436 a). National mine; H. (s); not sampled (427 e). Nelson mine; H.; one sample: Fe, P, S, Si, Al, Mn (434 f, 532 c). New York hematite mine; H.; not sampled (432 f). New York mine; H. (s); two samples: c.; two samples; Fe, P, S, Si, Al, Mn, Ti, Si (425 c, 530 b, 589). Orion mine; H.; not sampled (432 f). Palmer mine; H.; one sample: Fe, P, S, Si, Al, Mn (436 e, 532 e). Pendill mine; H.; not sampled (432 f). Pittsburgh and Lake Superior mine; H.; not sampled (436 d). Republic mine; product of iron ore in c. y., and its value and the number of employés (75 d); H. (s) and M.; two samples: c.; six samples: P., Fe, S, Si, Mn (431 c, 530 f, 587). Rolling Mill mine; H.; one sample: Fe, P, S, Si, Al, Mn (432 d, 532 b). Rowland mine; H.; not sampled (432 d). Saginaw mine; H. (s); one sample: Fe, P, S, Si, Al, Mn, Ti, Si (427 f, 530 c). Salisbury mine; H.; three samples: Fe, P, S, Si, Al, Mn (435 a, 532 d). Section 12 mine; H.; not sampled (434 b). South Jackson mine; H.; two samples: Fe, P, S, Si, Al, Mn (434 a, 532 c). Sterling mine; H. (s); three samples: Fe, P. (428 d, 530 d). Steward mine; M.; not sampled (431 b). Taylor mine; H.; not sampled (437 b). Wheat mine; H.; not sampled (436 e). Winthrop mine; H.; two samples: Fe, P, S, Si, Al, Mn (436 a, 532 d). Quartz and feldspar, statistics of the production of, in c. y. (844).

Menominee county Iron ore: Amount of each kind of iron ore mined in, in c. y. (24 c); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of iron ore in (44–47). Iron-ore mines: Breen mine; H.; three samples: Fe, P. (440 a, 532 e). Chapin mine; H. (s); two samples: c.; one sample; Fe, P. (451 a, 534 e, 589). Cornell mine; H. (s); two samples: c. (452 e, 534 e, 588, 589). Curry mine; H. (s); four samples; Fe, P. (442 e, 532 f). Cyclops mine; H. (s); five samples; Fe, P, S, Al (447 d, 534 c). Emmet mine; H. (s); eight samples; Fe, P, S, Si, Al. (437 f, 532 e). Lowell mine; H. (s); one sample: Fe, P. (440 c, 532 e). Ludington mine; H. (s); one sample: Fe, P. (451 f, 534 e). McKenna (or Keel Ridge) mine; H. (s); one sample; c.; one sample; Fe, P. (450 a, 534 e, 590). Norway & Cyclops mine, product of iron in c. y., and its value and the number of employés (75 d); H. (s); one sample: c.; seven samples: Fe, P. (455 d, 534 c, 589). Perkins mine (see Saginaw mine); H. (s); seven samples: Fe, P. (443 a, 534 a). Pit No. 3 or New Vulcan mine; H. (s); one sample: c.; five samples: Fe, P. (441 c, 532 f, 590). Quinnesec mine; product of iron in c. y. and its value and the number of employés (75 d); H. (s); five samples: c.; two samples: Fe, P, S, Si (448 c, 449, 534 d, 587, 588); Saginaw mine (Perkins); H. and H. (s); seven samples: Fe, P. (443 a, 534 b). Stephenson mine; H. (s); one sample: c.; five samples: Fe, P. (444 b, 534 b, 590). Vulcan mine; product of iron ore in c. y. and its value and the number of employés (75 d); H. (s); one sample: c.; one sample: Fe, P. (440 f, 532 f, 590).

Houghton county. Copper, statistics of the production of, in c. y. (798–799).

Isle Royale county. Copper, statistics of the production of, in c. y. (798–799).

Jackson county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Kalamazoo county. Hydraulic cement, statistics of the production of, in c. y. (841).

Keweenaw county. Copper, statistics of the production of, in c. y. (798–799).

Ontonagon county. Copper, statistics of the production of, in c. y. (798–799).

Shiawassee county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Mineral soap, statistics of the production of, by states and counties (843); by states (850–851).

Mines and metallurgical establishments east of 100th meridian, directory of (854).
Minor minerals of the United States (831–853); statistics of production of, in the census year (837–853).

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Iron-ores. Partial analyses of (546–547).

Iron ores. Report of a trip on the Upper Mississippi and to Vermilion lake, Minnesota, by Bailey Willis (457–467); *map* of a part of northern Minnesota, showing route traversed (457); letter of transmittal (451); magnetite ore near Agate bay (459 a); outline of trip to Upper Mississippi (459 c); *map* of the Pokegoma iron region (458); sketch of Pokegoma falls (459); sketch of the lower rapid, Prairie river (460); outline of trip to Vermilion lake (461 a); narrative (461 b); distorted bands of specular ore in Jasper (461); geology (462 b); Plates XXVII, XXXVIII, and XXXIX (462 f, 464 a); black slate and sandstone inclosed in schist (462); sketch-map of the Two Rivers range (463); notes on the occurrence of iron ore (464 e); crystallized quartz in specular ore, Two Rivers range (464); vertical section in the Two Rivers range, showing specular ore in banded jasper (465); sketch maps of an ore-body on the Vermilion range (465, 466).

Itasca county. Iron ore: Prairie River mine; M. and H. (s); one sample: Fe, P. (460 e, 546 f).

Lake county. Iron ore: Agate Bay; M.; one sample: Fe, P. (458 f, 546 f).

Saint Louis county. Iron ore: Two Rivers range; H. (s); two samples: Fe, P. (464 c, 546 f); Vermilion range; H. (s); four samples: Fe, P. (465 e, 466 f).

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Barytes. Statistics of the production of, in c. y. (839, 846–847).

Coal (bituminous). Statistics of the production of, in c. y. (658–661, 674–675).

Copper. Statistics of the production of, in c. y. (798–799).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States iron-ore product (19 e); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 e).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).

Iron ore. Amount and value of c. y.'s product and their per cent. of the amount and value of the United States' product (19 e, 74 e); average value per ton (19 d); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (24 c); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 a); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b); production of iron mines, 1883–1884 (34 b); royalty paid on each kind of ore mined in, in c. y. (32 c).

Iron ore. Statistics of the production of iron ore in c. y. (48–51, 64–69); general averages of these statistics (70–71).

Iron ore, Bessemer. Amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the U. S. (30 e); proportion of Bessemer ore produced in (31 a).

Iron ores. Partial analyses of (548–549); complete analyses of (591–592).

Iron ores. Archæan (5 a, 9 e, 10 a); of the sub-Carboniferous (15 d); of the Canadian (12 a); of the Canadian, yield of, in 1880 (12 e).

Iron ores. Notes on the samples of iron ore collected in, by W. M. Chauvenet; specular ores in porphyry (Archæan); Saint François county (403); Iron county (405); specular ores in sandstone (Lower Silurian); Salem district (Dent county); map of Dent county, showing banks of specular ore sampled (407); Phelps county, map of, showing banks of specular ore sampled (402); Crawford county, map of, showing sampled deposits of specular ore (416); Franklin county (419).

Lead and zinc ore. Statistics of the production of, in c. y. (806).

Lead. Statistics of lead-smelting works in c. y. (811); machinery employed in the reduction of lead ores (820); relation of product to lead ore consumed (820).

Nickel. Statistics of the production of, in c. y. (843, 850–857).

Nickel and cobalt matte. Statistics of the production of, in c. y. (844, 850–851).

Zinc. Average cost of materials, labor, etc., per ton of, in c. y. (824); percentage of capital employed in c. y. (824); per cent. of the total product of zinc obtained in c. y. (824); representation of the furnace plant of the zinc-smelters in c. y. (824); statistics of zinc-smelting works in c. y. (821).

Adair county. Coal (bituminous), statistics of the production of in c. y. (658–661).

Andrain county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Barton county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Bates county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

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Boone county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Carroll county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Callaway county. Coal (bituminous), statistics of the production of, in c. y. (658–651).

Cass county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Cedar county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Chariton county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Christian county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

Cole county. Coal (bituminous), statistics of the production of, in c. y. (658–651); lead and zinc ore, statistics of the production of, in c. y. (804–805).

Cooper county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Crawford county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); statistics of the production of iron ore in, in c. y. (48–51); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b). Iron-ore mines: Cherry Valley mine; H. (s); one sample: c.; two samples: Fe, P. (418 c, 548 b, 592). Clark mine; H. (s); one sample: Fe, P). 418 a, 548 b). Iron Ridge mine; H.; one sample: Fe, P. (417 a, 548 b). Marsh mine, H.; one sample: Fe, P. (417 c, 548 c). McGarvey mine; H.; one sample: Fe, P. (419 d, 548 c). Merimec Iron Mining Co.'s mine; product of iron ore in c. y. and its value and the number of employés (75 d). Railroad mine; H. (s); one sample: Fe, P. (48 a, 548 b). Scotia mine; disturbance of the ore-bodies in the; section (12). (No. 1) mine; H. (s); one sample: Fe, P. (418 f, 548 c). Zane mine; H.; one sample: Fe, P. (417 e, 548 b).

Dade county. Coal (bituminous), statistics of the production of, in c. y. (658–661). Iron ore, statistics of the production of iron ore in c. y. (48–51). Lead and zinc, statistics of the production of, in c. y. (804–805).

Dent county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); statistics of the production of, in c. y. (48–51); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b). Iron-ore mines: Fitzwater mine; H. (s); one sample: Fe, P. (413 a, 548 f). Hawkins mine; H.; one sample: Fe, P. (414 f, 548 e). Milsap and Orchard mine; H. (s); two samples: Fe, P. (410 b, 548 e). Nova Scotia (furnace) mine; H. (s); two samples: Fe, P. (408 b, 548 f). Pomeroy mine; H. (s); one sample: Fe, P. (410 c, 548 e). Riverside mine; H. (s); two samples: c. (409 b, 548 f, 529). Simmons Mountain mine; H. (s); one sample: Fe, P. (409 f, 548 e). Sligo Furnace mine; H.; two samples: Fe, P. (411 d, 548 f). Thomas mine; H.; one sample: Fe, P. (411 a, 548 e). Watkins mine, H.; one sample: Fe, P. S. (413 b, 548 e).

Franklin county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); statistics of the production of iron ore in, in c. y. (48–51). Lead and zinc, statistics of the production of, in c. y. (804–805). Iron-ore mines: Saint Clair or Busket mine; H. (s); two samples: Fe, P. (420 a, 548 b). Staunton mine; H.; two samples: Fe, P. (419 f, 548 a).

Gasconade county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); statistics of the production of, in, in c. y. (48–51).

Greene county. Lead and zinc ore, statistics of the production of, in, in c. y. (804–805).

Henry county. Coal (bituminous), statistics of the production of, in, in c. y. (658–661).

Iron county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 c); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); statistics of the production of, in c. y. (48–51). Iron ore mines: Cedar Hill mine; H. (s); one sample: Fe, P. (407 a, 548 c). Pilot Knob mine; H. (s); two samples: c.; one sample: Fe, P. (S) (405 a, 548 c, 591, 592); product of iron ore in c. y. and its value and the number of employés (75 d). Shepherd Mountain mine; H. (s); one sample: c. (406 c, 548 c, 591).

Jasper county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

Jefferson county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

Johnson county. Coal (bituminous), statistics of the production of, in c. y. 658–661).

La Fayette county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Lincoln county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

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Linn county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Livingston county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Macon county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Madison county. Lead and zinc ore, statistics of the production of, in c. y. (804–805); nickel, statistics of the production of, in c. y. (843).

Moniteau county. Coal (bituminous), statistics of the production of, in c. y. (658–661); lead and zinc ore, statistics of the production of, in c. y. (804–805).

Monroe county. Coal (bituminous), statistics of the production of, in c. y (658–661).

Newton county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

Morgan county. Lead and zinc ore, statistics of the production of, in c. y (804–805).

Nodaway county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Phelps county. Iron ore: Amount of each kind of ore mined in, in the c. y. (24 d); statistics of the production of iron ore in, in c. y. (48–51). Iron-ore mines: Brady mine (see Smith mine); H.; one sample: Fe,P. (414 a, 548 d). Clinton mine; H.; one sample: Fe,P. (414 a, 548 d). Grand Union and Mozelle mine; H.(s); three samples: Fe,P.(Cu) (415 f, 548 d). Horse Hollow mine; H.; one sample: Fe,P. (415 d, 548 d). Lamb mine; H.; one sample: Fe,P. (413 d, 548 d). Old Maramec mine; H.; one sample: Fe,P. (415 a, 548 d). Ozark mine; H.(s); one sample: Fe,P. (415 c, 548 d). Reed mine (see Grand Union mines) (415 f, 548 f). Stimson mine; H.; one sample: Fe,P. (414 d, 548 d).

Platte county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Putnam county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Ralls county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Randolph county. Coal (bituminous), statistics of the production of, in c. y (658–661).

Ray county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Saint Charles county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Saint Clair county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Saint François county. Iron ore, amount of each kind of iron ore mined in, in the c. y. (24 c). Iron-ore mines: Iron Mountain mine, product of iron ore in c. y. and its value and the number of employés (75 d); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of, in c. y. (48–51); character and position of the ores of (9 e); product of, in 1880 (9 f); H.(s); five samples: Fe,P. (403 c, 548 e). Lead and zinc ore, statistics of the production of, in c. y. (804–805). Nickel, statistics of the production of, in c. y. (843). Nickel and cobalt matte, statistics of the production of, in c. y. (844).

Saint Genevieve county. Copper ore, statistics of the production of, in c. y. (798–799).

Saint Louis county. Iron-ore mines: Missouri Furnace Company's mine; H.(s) one sample: Fe,P. (420 f, 548 c).

Saline county. Coal (bituminous), statistics of the production of, in. in c. y. (658–661).

Schuyler county. Coal (bituminous), statistics of the production of, in c. y. (658–661).

Sullivan county. Coal (bituminous), statistics of the production of, in c. y. (656–661.)

Vernon county. Coal (bituminous), statistics of the production of, in c. y. (658–651).

Washington county. Barytes, statistics of the production of, in c. y. (839). Iron ore: Amount of each kind of iron ore mined in the c. y. (24 d); statistics of the production of, in c. y. (48–51). Lead and zinc ore, statistics of the production of, in c. y. (804–806).

Wright county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

MONTANA.

Belt Butte, on Belt creek. Section of (742 f).

Belt creek. Mica-augite-trachyte of (723 b).

Belt mountains, at head of South fork of the Musselshell (741 a).

Big Belt range. An elliptical anticlinal of Paleozoic slates cut by granite dikes (705 e); distortions of this anticlinal; these slates form greater

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Big Belt range—Continued.

part of mountains (705 f); presumed structure of eastern flank; of western flank; "wash" of recent date; southerly extent of the slate anticlinal (706 a); a synclinal eastward; forming summits; extent of same; resemblance to Pennsylvania structure (706 b); lower quartzites and limestones west of slate anticlinal; extent of (706 c); their structure north of Boulder creek (706 d); slates of Boulder Creek valley; of Benton gulch; of Smith's river; probability of a fault between mountain center and Benton gulch (706 e); its character and effects; an unbroken monoclinal, equivalent of the slates farther north; measurement of series; cut off on north by fault at Dry Creek range; extent of displacement (706 f); increasingly persistent easterly strike on northern slope of valley next beyond quartzites (707 a); intrusive granitic rocks in central part of anticlinal; their effects; characterized by quartz and feldspar crystals; diabase weathering into soil on margin of mountains; near Greason and Boulder creeks (707 b); benches in basins of Deep and Boulder creeks; bench south of Diamond City (707 c); well preserved lateral moraine; its height above valley bottom (707 d).

Birdtail mountains. Eruptive rocks of (730 f).

Bozeman coal-field (746 b); analyses of coal from (780–783); horizon of its coals (698 c); its coal-seams (748 c); section of its strata (747 a); list of its fossils (747 c).

Bridger range at Flathead pass. Structural section across (700, sec. 2, 701 d); geological structure of (705 b); topographical form and extent of (705 b); structural relations of Paleozoic, Archæan, and Mesozoic rocks of (705 b); local anticlinals and synclinals observed by Hayden; supposed heavy fault in; reasons for it (705 c); overthrow of Carboniferous and Mesozoic at Flathead pass (705 c); valleys separating foothills from range; creeks flowing in them; age of foothills doubtful (705 d); change of dip and strike between range and foothills (705 e); Bridger uplift contemporaneous with that of other central Montana ranges—after represented epochs of Cretaceous (705 e).

Bull Mountain coal-field (753 c); analyses of coals from (782–785); physical characteristics of its coal (754 f).

Bull mountains. Topography of (753 d).

Cambrian series in Rocky Mountain range in Montana (719 e).

Cadotte's pass, over main range, section (structural) (700, sec. 8, 703 b).

Carboniferous limestone in Rocky Mountain range in Montana (720 a, 721).

Central: Cambrian in (697 c); Archæan in (697 c); Cretaceous in (698 a); in Cretaceous, Tertiary, and Post-Tertiary times (704 b); horizon of its coals (697; Jurassic in (698 a); Lower Carboniferous in (697 e); Mesozoic series in (697 f); mountain structures in (703–712); Potsdam limestone in (697 d); Quaternary in (698 a); Tertiary in (698 a).

Analyses of coals and lignites of (779–789); elementary composition of coals and lignites (790); Bozeman coal-field, analyses of coals (780–782); Bull Mountain coal-field, analyses of coals (782–785); Rock Creek coal-fields, analyses of coals (784–787); Gallatin Valley coal-field, analyses of coals (786, 787); Hell Gate, Missoula river, coal, analyses of (786, 787); Gardiner coal-field, analyses of coals (786, 787); Flathead river coal, analyses of (786, 787); Sun river coal, analyses of (786, 787); eastern Montana, analyses of coals (786, 787); Judith Basin coal-field, analyses of coals (784, 785).

Coal of Bozeman coal-field, Montana, its physical characteristics (756 d); of Bull Mountain coal-field, Montana, its physical characteristics (754 f); horizon of, in Bozeman coal-field, Montana (698 c); of Montana, horizon of (697).

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Colorado series in Montana (743 d).

Copper. Statistics of the production of, in c. y. (800).

Crazy mountains, eruptive rocks of (700, sec. 2, 701 e, 737 a).

Cretaceous formation in Montana, probable thickness of (746 a); fossils of central Montana (713 d, 714 c, 718 b); in Rocky Mountain range in Montana (719 e); in central Montana (698 a).

Dearborn district, Montana, eruptive rocks of (731 e); hornblende-andesite of (732 c); hornblende-dacite of (732 d); liparite of (732 a).

Dearborn river (Middle fork), Montana, section (columnar) (698 e, 699, sec. 8).

Diabase (quartz) of Big Belt mountains, Montana (735 e).

Drainage of Big Belt range, Montana (707 c); of Highwood mountains, Montana (710 b); of Little Belt mountains, Montana (709 d); of Rocky mountains (main range, over Cadotte's pass, Montana (712 d).

Eruptive rocks. By Waldemar Lindgren (719); of Montana, age of, *résumé* (737 b); of Big Belt range, Montana (707 a); of Big Belt mountains, Mon

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Eruptive rocks—Continued.
tana (734 d); of Birdtail mountains, Montana (730 f); of the Crazy mountains, Montana (737 a); in Crazy mountains, Montana (709, sec. 2, 701 e); of Dearborn district, Montana (731 e); of Highwood mountains, Montana (724 c); in Little Belt mountains, Montana (700, sec. 4, 702 d, 709 c); in front of main range of Rocky mountains, northern Montana, southwest of Fort Benton (730); of Mullen pass and Jefferson county, Montana (733 b); of Mullen pass, Little Blackfoot river, Montana (703 d); in Rocky mountains (main range over Cadotte's pass), Montana (711 c); of Sun River district, Montana (730 c).
Flathead pass (see Bridger range).
Flathead river, analyses of coals from (786, 787).
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Sussex county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 b); statistics of the production of iron ore in, in c. y. (48–51); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b). Iron-ore mines: Andover mine described; plan (151 e, 152); see Sulphur Hill mine (151 e, 550 d). Canistear mine described (154 d); M.; one sample: Fe,P,S. (154 e, 550 d). Davenport mine described (155 a); M.; one sample: Fe,P,S. (155 b, 550 e). Furnace Vein mine (see Hill mine) (153 e, 550 d). Green mine mentioned (154 d). Hill (or Furnace vein) mine described (153 d); M.; one sample: Fe,P,S.; one sample: c. (153 e, 550 d, 593). Hude or Stanhope mine described (158 d); M.: one sample; Fe,S,P. (158 f, 550 e). Wright or Budd mine described (158 b). Ogden mines described (154 f). Old Ogden mine mentioned (155 c). Pardee mine described (155 d); M.; one sample: c. (156 c, 550 d, 593). Pike's Peak or Furnace Vein mine described (see Hill mine). Pike's Peak or Stony Brook mine mentioned (174 e). Pochuck mine mentioned (177 a); L.; one sample: Fe,P,S. (177 b). Roberts mine described (155 c); M.; two samples: Fe,P,S. (155 d, 550 e). Roseville mine described (151 a); M.; one sample: Fe,S,P. (151 c, 550 e). Sulphur Hill mine; M.; seven samples: Fe,P,S,Mn,Ti; one sample: c. (151 e, 153 b, 550 d, 593). Sickles's mine; M.; one sample: Fe,S,P. (158 b, 550 c). Wawayanda mine mentioned (154 d). Welling mine mentioned (154 d). Williams' mine mentioned (154 d). Wright or Budd mine; M.; one sample: Fe,S,P. (158 c, 550 e).

Lead and zinc ore. Statistics of the production of, in c. y. ((804, 805).

Warren county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 d). Statistics of the production of iron ore in, in c. y. (48–51); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b). Iron-ore mines: Bald Pate mine mentioned (159 b); M.; one sample: Fe,P,S, (159 c, 550 c); Brown mine mentioned (176 f); see Shields mine (176 f). Carpenter mine mentioned (176 b). Egbert mine mentioned (158 f); M.; one sample: Fe,S,P, (550 c, 159 a). Jenny Jump mountain, exploration shafts sunk on (149 f). Kishpaugh mine described (149 c); M.; two samples: Fe,P,S,Mn,Ti (149 d, 550 c). New mine shaft described; plan (159 e); M.; four samples: Fe,P,S,Mn,Ti (160 a, 160 e, 550 c). Oxford Furnace mines described (159 c). Rapp mine mentioned (176 b). Riegel mine mentioned (176 b). Shields mine described (176 d); L.; one sample: c. (176 d, 550 c, 593). Staley mine mentioned (159 e). Swayze mine mentioned (177 a). Thomas mine mentioned (176 f); see Shields mine (176 f). Washington mine described (161 a); M.; two samples: Fe,P,S,Mn,Ti (161 b, 550 c). Welch mine mentioned (159 e, 160 e); M.; two samples: Fe,P,S,Mn,Ti (160 f, 550 c).

NEW HAMPSHIRE.

Copper ore. Statistics of the production of, in c. y. (798–799).

Iron ore: Notes on the samples of iron ore collected in, by Edward R. Benton (80). Iron-ore sample *map* of Vermont and part of New Hampshire (81).

Mica. Statistics of the production of, in c. y. (843, 850–851).

Quartz and feldspar. Statistics of the production of, in c. y. (844, 852–853).

Scythe-stones. Statistics of the production of, in c. y. (845, 852–853).

Soapstone. Statistics of the production of, in c. y. (845, 852–853).

Grafton county. Copper, statistics of the production of, in c. y. (789–799); Mica, statistics of the production of, in c. y. (843); Scythe-stones, statistics of the production of, in c. y. (845). Iron ores, partial analyses of (550–551). Iron-ore mines: Franconia mine described (80 a); M.; one sample: Fe,P. (80 b, 550 b).

Hillsborough county. Soapstone, statistics of the production of, in c. y. (845).

NEW MEXICO.

Coal. Analysis of Raton (788–789).

Copper. Statistics of the production of, in c. y. (800).

Iron ores, partial analyses of (552–553).

Colfax county. Maxwell landgrant; M.; one sample. Fe,P. (499 f, 552 f).

Santa Aña county. Union mine; M.; one sample: Fe,P. (499 d, 552 f).

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Asbestos. Statistics of the production of, in c. y (839, 846–847).

Glass-sand. Statistics of the production of in, in c. y. (840, 848–849).

Graphite. Statistics of the production of, in c. y. (841, 848–849).

Hydraulic cement. Statistics of the production of, in c. y. (841, 848–849).

Hydraulic lime. Statistics of the production of, in c. y. (841, 848, 849).

Iron. Amount in ore mined in c. y. and its per cent. of total iron in the United States' iron-ore product (19 e); amount of iron in the different kinds and grades of ore mined, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 e).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 e); to total amount of ore (74 e).

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Iron ore. Amount and value of the c. y.'s product, and their per cent. of the amount and value of the United States' product (19 e, 74 c); average value per ton (19 e); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (24 e); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 a); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b); average value of ore produced in, compared with New Jersey (20 d); product of iron ore in c. y. and its value and the number of employés in the mines (75 d); royalty paid on each kind of ore mined in c. y. (32 c).

Iron ore. Statistics of the production of, in c. y. (48–51, 64–69); general averages of these statistics (70–71).

Iron ore, Bessemer, amount of each kind mined in c. y. (30 e); proportion of Bessemer ore produced (31 a).

Iron ores. Complete analyses of (593, 594); partial analyses of (554–559).

Iron ores, Archæan, character and disposition of (7 f). Spathic ores (12 f). Clinton hematite ores (13 a).

Iron ores. Notes on the samples of iron ore collected in New York, by Bayard T. Putnam (89–144). *Map* of New York (geologically colored) showing position of iron mines (Plate XXV). MAGNETIC ORES (90); *map* showing location of iron mines in Orange and Putnam counties (90); Orange county (91); Putnam county (95). Washington county: *Map* of a portion of Washington county showing position of iron mines (105 c). Essex and Clinton counties: *Map* of the Lake Champlain iron region (107). Franklin and Saint Lawrence counties (112 c). LIMONITES.—Richmond county (Staten island): Geological *map* of Staten island (123 a); *map* of part of Staten island showing location of iron mines (123 d). Orange county. Dutchess and Columbia counties: *Map* showing location of iron mines east of the Hudson river (128). Columbia county (135). CARBONATE ORE (136). FOSSIL ORE.—Oneida county: *Map* of a portion of, showing position of fossil ore-mines (137); *map* showing the outcrop of the fossil ore-bed near Clinton (138). Wayne county: *Map* showing the outcrop of the fossil ore-bed in Ontario township (140). HEMATITE.—*Map* showing the location of the hematite ore-mines in Jefferson and Saint Lawrence counties (141).

Kaolin, statistics of the production of, in c. y. (842, 848–849).

Pyrites, statistics of the production of (for sulphuric acid), in c. y. (844, 852–853).

Quartz and feldspar, statistics of the production of, in c. y. (844, 852–853).

Talc, statistics of the production of, in (845, 852–853).

Clinton county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (24 e); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); statistics of the production of iron ore in c. y. (48–51). Iron-ore mines: Arnold Hill mine described (119 c); M.; six samples: Fe,P,Ti (119 c, 120 c, 558 b). Bowen & Signor's mine described (120 e); M.; two samples: Fe,P,Ti (120 f, 558 a). Chateaugay mine described (121 b); M.; three samples: Fe,P,Ti (121 b, 558 c); output of iron ore, 1883–1884 (34 b). Mine 81 described (122 a); M.; two samples: Fe,P,Ti (122 b, 558 c). Nelson Bush mine described (120 c); M.; two samples: Fe,P,Ti (120 d, 558 b). Palmer Hill mine described; plate (118 e); M.; four samples: Fe,P. (119 b, 556 f). Tremblay's mine described (121 a); M.; two samples: Fe,P,Ti (121 a, 558 b).

Columbia county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); description of the iron-ore deposits in (127 c, 135 b); occurrence of carbonate ore in (136 a); statistics of the production of iron ore in c. y. (48–51). Iron ore mines: Columbia Spathic Ore Company's mine; one sample: Fe,P. (136 a, 554 d). Copake mine mentioned (135 a); M.; two samples: Fe,P. (135 e, 554 d). Haight mine mentioned (135 f). Hillsdale mine mentioned (135 f). Mitchell mine mentioned (135 f). Reynolds mine mentioned (135 f); M.; one sample: Fe,P. (135 b, 554 d). Weed mine mentioned (135 c); M.; one sample: Fe,P. (135 d, 554 d).

Dutchess county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); description of iron-ore deposits in (127 c, 128 d); New York and Harlem Railroad belt of ores described (130 e); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of iron ore in c. y. (48–51). Iron-ore mines: Amenia mine described; plan (132 e, 133); L.; one sample: Fe,P. (132 f, 556 c). Beekman mine described (129 d); L.; two samples: Fe,P,Mn (129 f, 556 a). Clove mine described (130 b); L.; two samples: Fe,P. (130 b, 556 b). Clove Spring mine described (130 b); L.; two samples: Fe,P. (130 d, 556 b). Dakin mine described (134 f); L.; one sample: Fe,P. (135 a, 556 a). Dover mine described (131 f); L.; two samples: Fe,P. (132 a, 556 b). Fishkill mine described (128 c); L.; one sample: c. (128 e, 556 b, 594). Gridley mine described (132 b); L.; one sample: Fe,P.; one sample: c. (132 c, 556 c, 594). Maltby mine described (134 b); L.; two samples: Fe,P. (134 d, 556 c).

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Dutchess county—Continued.

Manhattan mine described; plan (133, 134 a); M.; two samples: Fe,P,Mn (134 b, 556 c). Pawling mine described; plan (131 a); L.; two samples: Fe,P. (131 e, 554 f). Riga mine described; plan (134 d); L.; one sample: Fe,P. 134 f, 556 c). Sylvan Lake mine described (129 b); L.; two samples: Fe,P,Mn (129 d, 556 b). Tower's Spring mine (see Clove Spring mine); L.; two samples (130 b, 556 c). Valley Pond mine described (130 e); L.; two samples: Fe,P. (130 f, 556 a). Kaolin, statistics of the production of, in c. y. (842).

Erie county. Hydraulic cement, statistics of the production of, in c. y. (841).

Essex county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of iron ore in c. y. (48–51). Iron-ore mines: Mines in Schroon township mentioned (118 a). Mineville mines, position of the ore-bodies in the, section (7 c). Barton Hill mine described; plan (108 b, 109); M.; one sample: Fe,P,Ti (108, 556 f); character of the ore in (7 c). Brinsmade mine described (110 a); M.; one sample: Fe,P,Ti (see Welch shaft) (110 a, 111 c, 556 e). Cheever ore-bed described; plan (112 e, 113); M.; six samples: Fe,P,Ti (112 d, 556 d); mentioned (106 f). Cook's mine mentioned (106 f, 108 b). Crown Point mines described; map (116 b, 117); product of iron ore in c. y. and its value and the number of employés (75 d); M.; four samples: Fe,P,Ti (116 d, 556 e). Fisher Hill mine mentioned (108 b); M.; one sample: Fe,P,Ti (108 e, 556 d); character of the ore in (7 c). Gate's or Putnam mine described (118 c); M.; two samples: Fe,P,Ti (118 b, 556 c). Hale mine described (118 c); M.; two samples: Fe,P.Ti (118 e, 556 e). Lee mine described; plan (115 a); M.; two samples: Fe,P,Ti (116 b, 556 c); mentioned (108 a). Miller mine described (110 a); M.; one sample; Fe,P,Ti (111 c, 556 f); section through Miller pit (7 e). Mine 21 described (110 e); M.; three samples: Fe,P,Ti (111 c, 556 d); mentioned (106 f, 108 c); ore-bodies in (7 d); product of iron ore in c. y. and its value and the number of employés (75 d). Mineville mines described (108 a). New Bed mine described; plan (108 b, 109); M.; one sample: Fe,P,Ti (108 e, 556 d); character of the ore in the (7 c). Nolan shaft; M.; one sample: Fe,P,Ti (111 c, 556 c). Old Bed mine described (110 b); M.; three samples: Fe,P,Ti (111, 112, 556 f); mentioned (106 f, 108 b); product of iron ore in c. y. and its value and the number of employés (75 d). Pott's shaft; M.; one sample: Fe,P,Ti (111 c, 556 f). Putnam's or Gate's mine; M.; two samples: Fe,P,Ti (118 c, 556 e). Smith mine (Cook's shaft) described (112 c); M.; two samples: Fe,P,Ti (112 d, 556 d); mentioned (106 f). Tefft shaft; M.; one sample: Fe,P,Ti (111 c, 556 f). South Barton Hill mine; M.; one sample: Fe,P,Ti (108 e, 556 d). Welch shaft (see Brinsmade mine); M.; one sample: Fe,P. (110 a, 111 c, 556 e).

Franklin county. No ore produced in 1880 in (122 c).

Jefferson county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (24 e); statistics of the production of iron ore in, in c. y. (48–51). Map showing the location of the hematite ore mines (141); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 d). Iron-ore mines: Dickson mine described (142 f); H.; one sample: Fe,P. (142 f, 558 d). Keene mine described (143 b); H.; one sample: Fe,P. (143 d, 558 d). Old Sterling mine described (142 f); H.; one sample: Fe,P. (143 b, 558 d). Shittleff mine described (142 c); H.; one sample: Fe,P. (142 e, 558 d).

Oneida county. Glass-sand, statistics of the production of in c. y. (840). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); deposits of fossil ores in, map (136 d); map of a portion of Oneida county, showing position of fossil ore mines (137); map showing the outcrop of the fossil ore-bed near Clinton (138); statistics of the production of, in c. y. (48–51). Iron-ore mines: Butler ore-bed described (138 d); F.; one sample: (138 d, 139 a, 558 c). Caglin's mine mentioned (140 b); F.; one sample: Fe,P. (140 c, 558 c). Clinton mine described (138 e). Davis mine described (136 f); F.; one sample: Fe,P. (137 a, 558 c). Derwin's farm mine mentioned (139 e); F.; one sample: Fe,P. (139 f, 558 c). Ellingwood mine mentioned; F.; Fe,P. (137 e). Elliott mine mentioned; F.; Fe,P. 139 c). Franklin and Clinton mines described (138 e); F.; five samples: c; one sample: Fe,P. (138, 139 b, 558 c). John Klein's mine mentioned (140 a); F.; one sample: Fe,P. (140 a, 558 a). Norton's mine; F.; one sample: Fe,P. (139 d, 558 c). Pryer mine mentioned (139 d); F.; one sample: Fe,P. (139 f, 558 c). Wells mine described (137 d); F.; one sample: Fe,P. (137 d, 558 d).

Onondaga county. Hydraulic cement, statistics of the production of, in c. y. (841). Hydraulic lime, statistics of the production of in c. y. (841).

Orange county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); statistics of the production of iron ore

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Orange county—Continued.
in, in c. y. (48–51); limonite deposit in, described (127 b); magnetic ores, remarks on the (89 c); map showing location of iron mines in Orange and Putnam co.'s (90). Iron-ore mines: Bering mine mentioned (89 f). Bull mine described (93 b); M.; one sample: Fe,P,S,Ti, Mn (554 b). Canterbury mine; M.; one sample: Fe,P,Mn (127 c, 554 c). Clove mine mentioned (93 b). Cornwall Hematite; L.; one sample: Fe,S,P,Ti,Mn (554 c). Crawford mine described (89 e); M.; one sample: Fe,P,S,Mn,Ti (554 a). Ferro Hill mine mentioned (93 e). Forest of Dean mine described; sec. (93 f); M.; one sample: Fe,P,S. (94 b, 554 c). Forshee O'Neil or "Nail" mine described (92 f); M.; one sample: Fe,P,S,Mn (93 b, 554 b). Greenwood mines mentioned (see Hogencamp, Pine Swamp) (92 e). Hogencamp mine described (92 e); M.; one sample: Fe,S,P,Mn (92 f, 554 b). Lake mine mentioned; M.; one sample: Fe,S,P,Mn (92 a, 554 b). Mines west of the Hudson river mentioned (94 c). Oregon mine; M.; one sample: Fe, S,P,Mn,Ti (90 d, 554 b). Queensborough mine (near) mentioned (94 c). Redback or Spruce Swamp mine described (91 a); M.; one sample: Fe, P,S. (91 b, 554 a). Scott or Oregon mine described (92 c); M.; one sample: Fe,S,P,Ti,Mn (92 d, 554 b). Spruce Swamp or Redback mine; M.; one sample: Fe,P,S. (91 b, 554 a). Sterling mine described; map (91 b); M.; two samples: Fe,S,P. (91 f, 554 f). Summit mine; M.; one sample: Fe, S,P,Mn,Ti (92 c, 554 b). Stevens' mine; M.; one sample: Fe,S,P,Mn,Ti (92 d, 554 d). Taylor mine mentioned (93 d). Tiptop or Summit mine described (92 b); M.; one sample: Fe,S,P,Mn,Ti (92 c, 554 b). Warwick mine mentioned; M.; one sample: Fe,P,S. (93 e, 554 b).
Oswego county. Glass-sand, statistics of the production of, in c. y. (840).
Putnam county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 d); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); statistics of the production of iron ore in, in c. y. (48–51); magnetic ores, remarks on the (89 c, 94 e); map showing location of iron mines in Orange and Putnam counties (90). Iron-ore mines: Brewster mine described (101 d); M.; one sample: Fe,P. (102 a, 554 e). Canada mines mentioned (98 b). Croft mine described; plan; sec. (95 a, 96); M.; two samples: Fe,P. (554 d). Denny mine mentioned (98 b). Hill mine described (98 c); M.; one sample: Fe,P. (98 d, 554 e). Lake Mahopac Iron Company's mine described; plan (98 c, 99); M.; one sample: Fe,P,Mn. (554 e). West Point furnace; M.; one sample: Fe,P. (99 a, 554 e). McCollum mine described; map (100 a); M.; three samples: Fe,P,Ti,Mn (101, 554 e). Pratt mine mentioned (98 a); M.; one sample: Fe,P. (98 a, 554 e). Rose mine mentioned (98 b); M.; one sample: Fe, P,Mn (98 c, 554 e). Sackett mine mentioned (98 a); M.; one sample: Fe, P. (554 e). Stuart or Sunk mine described; plan; sec. (97 a); M.; one sample: Fe,P,Ti (554 e). Theall mine described; map (100 a); M.; one sample: Fe,P. (101 c, 554 e). Tilly Foster mine described; plan (102 a, 103 e); M.; nine samples: Fe,P.; two samples: c. (103–105, 554 f, 593, 594); product of iron ore in c. y. and its value and the number of employés (75 d); referred to (98 f). Todd mine described; map (94 e); M.; one sample: Fe,P. (94 f, 554 d).
Rensselaer county. Graphite, statistics of the production of, in c. y. (841).
Richmond county. Asbestos, statistics of the production of, in, in c. y. (839). Geological map of Staten Island (123). Map of part of Staten Island showing location of iron mines (123). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); statistics of the production of, in c. y. (48–51). Iron-ore mines: Cooper & Hewitt's mine described; plan (126 d); L.; three samples: Fe,P,Mn (126 d, 127 b, 554 c). New Dorp mine described; plan (124 a, 125); mentioned (122 f); M.; three samples: Fe, P,Ti,Mn; one sample: c. (124 b, 554 c, 594). Towle mine mentioned; plan (122 f, 124 e, 125). Tolles' (John) mine; L.; one sample: Fe,P. (126 f, 554 c). Tyson Four Corners mine described; plan (124 f, 125); L.; three samples: Fe,P,Mn,Ti,Cr (126 b, 554 c).
Rockland county. Steven's mine; M.; one sample: Fe,P. (94 d, 554 d).
Saint Lawrence county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 e); statistics of the production of, in c. y. (48–51); iron-ore deposits known in (122 c); map showing the location of the hematite ore mines (141). Iron-ore mines: Alpine furnace (see Jayville mine); M.; one sample: Fe,P,Ti (122 d, 558 e). Caledonia mine described (143 d); H.; three samples: Fe,P. (143 f, 558 e). Jayville mine (see Alpine furnace); M.; one sample: Fe,P,Ti (122 d; 558 e). Kearney mine: H.; one sample: Fe,P. (144 b, 558 e). Kearney mine described (144 a). Little Kearney mine described (144 a); H.; one sample: Fe,P. (144 b, 558 e). Pyrite (for sulphuric acid), statistics of the production of, in c. y. (844). Talc, statistics of the production of, in c. y. (845).
Sullivan county. Quartz and feldspar, statistics of the production of, in c. y. (844)
Ulster county. Hydraulic cement, statistics of the production of, in c. y. (841).

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Washington county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); map of a portion of Washington county, N. Y., showing position of iron mines (115); statistics of the production of, in c. y. (48–51). Iron-ore mines: Mount Hope mine described (106 b); M.; one sample: Fe,P,Ti (106 e, 556 e). Pedunk mine mentioned (115 e). Potter mine described; plan (115 c); M.; one sample: Fe,P,Ti (102 a, 556 c). Quartz and feldspar, statistics of the production of, in c. y. (844).
Wayne county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of iron ore in, in c. y. (48–51); iron-ore deposits in, described; map (140 c); map showing the outcrop of the fossil ore-bed in Ontario township (140). Iron-ore mines: Bennett's mine mentioned (140 f); not sampled (140 f). Bundy's mine; F.; one sample: Fe,P. (141 b, 558 d). La Frois's (J.) mine; F.; one sample: Fe, P. (141 b, 558 d). Ontario Furnace Company's mine; F.; four samples: Fe,P. (141 b, 558 d).
Westchester county. Iron ore: Verplanck Point mine; M.; one sample: Fe,P. (94 d, 554 d).
Nickel, statistics of the production of, by states and counties (843); by states (850–851).
Nickel and cobalt matte, statistics of the production of (844, 850–851).
NORTH CAROLINA.
Coal (bituminous), statistics of the production of, in c. y. (662–665, 674–675).
Copper. Statistics of the production of, in c. y. (798–799).
Corundum. Statistics of the production of, in c. y. (840, 846–847).
Graphite. Statistics of the production of, in c. y. (841, 848–849).
Iron. Amount in ore mined in c. y. and its per cent. of total iron in the United States' iron-ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 f).
Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).
Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 b, 74 e); average value per ton (19 f); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 f); amount of each kind of ore mined in each county in the c. y. (24 f); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in, in c. y. (29 b, 30 b).
Iron ore. Statistics of the production of, in c. y. (52–55, 64–69); general average of these statistics (70, 71).
Iron ore. Bessemer, amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e).
Iron ores. Partial analyses of (558–563); complete analyses of (594–596).
Iron-ore. Blackband, with Triassic coal (16 a); character of Laurentian, in (7 a).
Iron ores. Notes on samples of iron ores collected in North Carolina, by Bailey Willis (301–329); iron-ore sample *map* of North Carolina (geologically colored) (Plate XXXII); ores near Gaston, Halifax county (301 d); sketch *map* of vicinity of Gaston (301); bog-ores of eastern countries (302 b); specular, hematite, limonite, and blackband ores of Chatham, Moore, Harnett, and Johnson counties (302 f); Chapel Hill mine (306 f); titaniferous magnetite of Guilford and Rockingham counties (308); magnetic ores of Stokes and Surry counties (311); magnetic and limonite ores of Lincoln and Gaston counties, North Carolina, and York county, South Carolina.
Mica, statistics of the production of, in c. y. (843, 850–851).
Soapstone, statistics of the production of, in, in c. y. (845, 852–853).
Ashe county. Copper, statistics of the production of, in c. y. (798–799). Iron ores: Upper Laurentian magnetic ores of (324 b). Ashe and Johnston counties, map of portions of, showing location of iron mines (324). Iron-ore mines: Ballow (N. B.) mine, near Helton creek; Upper Laurentian; described; M.; one sample: Fe,P. (325 b, 562 b). Hampton's mine; M.; one sample: Fe,P. Horse Creek mine (Graybeal and Hampton); Upper Laurentian; described; M.; one sample: Fe,P. (324 e, 562 b). Johnson's ridge of Elk Knob; L.; one sample: Fe,P, Cu. (562 b). Poison Branch mine, near New river; Upper Laurentian; described; M.; two samples: Fe,P, S (325 a, 562 b).
Burke county. Upper Laurentian Titaniferous magnetite of (322 d). Propst's (N.) mine; described; sketch map (322 d); L.; one sample: Fe,P. (322 e, 560 b).
Caldwell county. Upper Laurentian limonite of (322 d). Curtis mine; M.; one sample: Fe,P. (323 a, 560 e).
Catawba county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of iron ore in c. y. (52–55).

NORTH CAROLINA—Continued.

Chatham county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Character of the blackband ore in (16 e); Triassic hematite and Huronian limonite of (303 e); Triassic hematite of (305 a). Iron-ore mines: Evans mine; Huronian; described (304 d); H.; one sample: Fe,P. (304 d, 558 f). Gulf mine; L.; one sample: Fe,P. (306 f, 558 f). Horton's (J. L.) mine; Triassic; described; C. (blackband); two samples: Fe,P. (306 d, 558 f). Smith mine, near Lockville; Triassic; described; sketch-map (305 b); H.; one sample: Fe,P. (560 b). Ore Hill mine; Huronian; described; sketch-map; L. and H.; three samples: two Fe,P.,S, one c (303 c, 558 f, 560 a, 594).

Cherokee county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of iron ore in c. y. (52–55). Huronian limonite of (327 e). And Fannin county, Georgia, map of portions of, showing location of iron mines (328). Iron-ore mines: Little's mine, near Murphy; Huronian; described (328 f); L.; one sample: Fe,P. (562 a). Monteith's mine, near Murphy; Huronian; described (328 f); one sample: Fe,P. (562 a). Morse mine; Huronian; described; L.; one sample: Fe,P. (327 e, 560 f). Section Six mine, near Murphy; Huronian; described (328 d); L.; one sample: Fe,P,S (560 f). Tomotla mine; Huronian; L.; one sample: Fe,P. (327 f, 560 f). Soapstone, statistics of the production of, in c. y. (845).

Duplin county. Iron mines: Boney (D. T.) bog; one sample: Fe,P. (302 c, 558 f).

Forsythe county Lower Laurentian: Titaniferous magnetic ore of (308 c).

Gaston county. Iron ore: Hematite (martite) in (320 d); Huronian magnetic ore of (316 f); limonite of Ormond and Mine mountain mines (321 c); limonite ore in (320 d). Iron-ore mines: Costner mine; Huronian?; described (318 a); M.; two samples: Fe,P. (560 d). Crowder's mountain mine; Huronian; described; sketch-map (320 d); M. and L.; two samples: Fe,P. (560 e). Ellison mine; Huronian?; described (318 c); M.; one sample: Fe P. (560 d). Mine Mountain mine, near Whetstone mountain; Huronian; described (321 f); L.; two samples: c. (560 d, 595). Ormond mine, near King's Mountain station; Huronian; described; sketch-map (321 c); L.; one sample: Fe,P. (560 e). Yellow Ridge mines; Huronian?; described; sketch-map, sections; M.; three samples: Fe, P,S (318 d, 560 e).

Guilford county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of, in c. y. (52–55); Titaniferous magnetic ore of (308 c). Iron ore mines: Tuscarora mine; Lower Laurentian; described; sketch-map (308, 309); M.; one sample: Fe,P. (560 b).

Halifax county. Iron ores near Gaston (301 d); sketch-map; described (301 d); 5 miles south of; surface pieces; M.; one sample: Fe,P. (302 a, 558 e).

Harnett county. Buckhorn mine; Huronian; described; section (304 e); H.; one sample: Fe,P. (558 f).

Haywood county. Mica, statistics of the production of, in c. y. (843).

Jackson county. Mica, statistics of the production of, in c. y. (843).

Johnston county. Iron ore: Huronian limonite of (302 f); and Ashe county, map of portions of, showing location of iron mines (224). Iron-ore-mines: Wilson's Mills mine; Huronian; described (302 f); L.; one sample: Fe, P. (558 f).

Lincoln county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of iron ore in c. y. (52–55); Huronian magnetic ore of (316 f); Lower Laurentian magnetic ore of (316 f). Iron-ore mines: Big mine; Huronian?; described; sketch-map (316 f); M.; one sample: c. (560 d, 595). Forney mine; Lower Laurentian; described (316 e); M.; one sample: Fe,P. (560 d). Killian's mine; Lower Laurentian; described (316 e); M.; one sample: Fe,P. (560 d).

Macon county. Corundum, statistics of the production of, in c. y. (840). Mica, statistics of the production of, in c. y. (843).

Madison county. Corundum, statistics of the production of, in c. y. (840). Iron ore: Upper Laurentian magnetic ores of (327 c). Iron-ore mines: Big Ivy (Eller's) mine; described; section (327 b); M.; one sample: Fe,P.; (327 c, 560 f).

McDowell. Mica, statistics of the production of, in c. y. (843).

Mitchell county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (24 f); statistics of the production of iron ore in c. y. (52–55). Mica, statistics of the production of, in c. y. (843). Upper Laurentian magnetic ores of (326 f). Iron-ore mines: Cranberry mine; described; sketch map (325 d, 326); M.; two samples: c.; two samples: Fe,P.,S. (325 f, 560 f, 596). Greasy Creek mine; M.; one sample: Fe,P. (327 a, 560 f).

Moore county. Iron ore: Hematite in the Trias in (16 e); Triassic blackband and ball ore of (306 d); Triassic hematite of (305 a); Triassic limonites of (306 e). Iron-ore mines: Cole mine, near Lockville; Triassic; described; sketch map, section (329); H.; one sample: Fe,P. (306 a, 560 b). Gulf mine, half mile west of the gulf; Triassic; described (306 d).

NORTH CAROLINA—Continued.

Nash county. Iron ore: Bog-ore in (302 d). Iron-ore mines: Bloomary mine, near Toisnot swamp; Tertiary; recent; described; section; bog; one sample: Fe,P. (302 d, 558 f).

Orange county. Iron ore: Huronian specular ores of (306 f). Iron-ore mines: Chapel Hill mine; Huronian?; described; sketch-map and sections (306 f, 307); H.(s); one sample: Fe,P,S; one sample c. (560 e, 595).

Rockingham county. Iron ore: Titaniferous magnetic ore of (308 c). Iron-ore mines: Dannemora mine; Lower Laurentian; described; sketch-map (303, 310); M.; one sample: c.; one sample: Fe,P,S. (560 b, 595).

Stokes county. Iron ore: Huronian magnetic ores of (311 d). Iron-ore mines: Sketch-map of vicinity of Danbury (312); Cherry mine, near Danbury; Huronian (314 f). Danbury, 8 miles west of; L.; one sample: Fe,P. (316 c, 560 c). Hard-Ore mine, near Danbury; Huronian; described; M.; one sample: Fe,P. (311 d, 560 b). Nelson's mines, near Danbury; Huronian; described; sketch-map and section (313); M.; two samples: Fe,P. (311 f, 312 a, 313 a, 560 c). Pepper mine, near Danbury; Huronian; described (314 f); M.; one sample: Fe,P. (560 c). Roger's mine, near Danbury; Huronian; described; sketch-map (313 f); M.; one sample: c. (560 c, 595). Smith's mine, near Danbury; Huronian (313 d).

Surry county. Iron ore: Amount of each kind of ore mined in, in the c. y. (24 f); statistics of the production of iron ore in, in c. y. (52–55); Upper Laurentian magnetic ores of (315 b). Iron-ore mines: Bullington mine, near Pilot Mountain post-office; Upper Laurentian (315 d). Crowders mine; Upper Laurentian (316 b). Ferris mine, near Pilot Mountain post-office; Upper Laurentian; described; M.; four samples: Fe,P,S (315 b, 560 c). Hyatt's bank; M.; two samples: Fe,P, see Pilot Mountain mine (315 d, 560 c). Pilot mountain, see Hyatt's mine (7 miles west of post-office); described; section (315 d); M.; two samples: Fe,P. (315 d, 560 c). Poplar Branch mine; Upper Laurentian; described; M.; one sample: Fe,P. (316 f, 560 d). Stanley's mine; Upper Laurentian (316 f). William's mine; Upper Laurentian; described; M.; one sample: Fe,P. (316 b, 560 c).

Swain county. Soapstone, statistics of the production of, in c. y. (845).

Wake county. Graphite, statistics of the production of, in c. y. (841).

Watauga county. Iron-ore mines: Ramsour's mine (see Richland's mine) (324 a, 560 f). Richland's mine; Huronian?; described; H.(s); one sample: Fe,P. (324 a, 560 f).

Yancey county. Mica, statistics of the production of, in c. y. (843).

O.

Ocher, statistics of the production of, by states and counties (844); by states (850–851).

OHIO.

Coal (bituminous), statistics of the production of, in c. y. (662–665, 674–675).

Iron. Amount in ore mined in c. y. and its per cent. of the total ore in the United States' ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 e); average per cent. of iron in ore mined in c. y. (19 f).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 d); amount of each kind and grade, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b); amount of each kind of ore mined in each county in the c. y. (25 a); amount of each kind of ore mined in each geological horizon in c. y. (21 b); amount of each kind of ore mined in c. y. (23 b); tonnage and value of low-grade Carboniferous ores in (20 a); royalty paid on each kind of ore mined in c. y. (32 c).

Iron ore. Statistics of the production of, in c. y. (52–55, 64–69); general average of these statistics (70–71).

Iron ores. Partial analyses of (562–565).

Iron ores. Phosphorus-iron ratio in ores from (32 a); occurrences of block-ore in the sub-Carboniferous limestone in (15 d); horizons of the kidney-ores in (16 b); horizons of carbonate ores in (16 b); ferriferous limestone ores in (16 c).

Iron ores. Notes on the samples of iron ore collected in, by Bailey Willis (235–243); *map* of the iron ores of the Coal Measures (236); general *section* of the Ohio Coal Measures, showing approximate relation of the iron ores sampled (237). Blackband (238 c); block-ores: Professor Orton's classification of (239 b); limestone kidney-ore near Zoar and Dover (240 a); limestone ore (240 e); Tuscarawas blackband (241 d); Iron Point blackband (242 e); Columbiana county ores (242 f); kidney or pebble ore of Middle fork of Little Beaver river (243 a).

OHIO—Continued.

Athens county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55). Iron-ore mines: Orbiston mine; C.; (blackband) one sample: Fe,P. (242 e, 584).

Belmont county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Carroll county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Columbiana county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55). Iron-ore mines: Cherry Valley Iron Company's mine; L. and C.; two samples: Fe,P.; (243 a, 564 d). Denman (William); C. and L.; two samples: Fe,P. (243 a, 564 d). Henry's (John) mine, at Mineral Ridge; Coal Measures; described (238 b). C. (blackband); two samples: Fe,P., (238 c, 564 d). Lewis's (Capt. B. F.) mine; C.; one sample: Fe,P. (243 a). Smith (A. G.); C.; two samples: Fe,P. (243 a, 564 d). Todd, Wells and Company's mine at Mineral Ridge; Coal Measures; described (238 b); C. (blackband); two samples: Fe,P, (238 b, 564 d).

Coshocton county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Cuyahoga county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55).

Gallia county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55).

Guernsey county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Harrison county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Hocking county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55). Iron-ore mines: Buchtel mine: C.; one sample: Fe,P. (241 b, 564 a). Gore furnace; L.; two samples: Fe,P. (240 f, 562 f).

Holmes county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Jackson county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 a); statistics of the production of, in c. y. (52–55). Iron-ore mines: Milton Furnace mines, near Herndon; Coal Measures; described (239 e); C.; two samples: Fe,P, (239 e, 562 e). Monroe Furnace mines; Coal Measures; described (239 d); C. L. H.; six samples: Fe,P. (259 e, 240 e, 562 e). Byers' station mine (Ray's ore), near Jackson; Coal Measures; described (238 f). Ray's mine; L.; one sample: Fe,P. (238 f, 562 e). Springfield Southern Railroad Company's mine (Davis ore), near Jackson; Coal Measures; described; section (238 d); C. Swaringen Farm mine, near Milton; Coal Measures; described (239 f); C.; one sample: Fe,P, (239 f, 240 f, 562 f).

Jefferson county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Lawrence county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of, in c. y. (52–55). Iron-ore mines: Davis mine; C.; five samples: Fe,P, (238 f, 562 e). Hecla furnace mines; Coal Measures; described (241 a); C.; five samples: Fe,P. (562 e). Hudson drift; C.; two samples: Fe,P. (240 e, f, 562 d). Lawrence furnace; C.; one sample: Fe,P. (562 e). Olive (furnace) mine; C. (blackband); two samples: Fe,P. (242 e, 562 e). Washington furnace; C.; five samples: Fe,P. (240 e, f, 562 d).

Mahoning county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of, in c. y. (52–55).

Medina county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Meigs county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Monroe county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Morgan county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Muskingum county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of, in c. y. (52–55). Iron-ore mines: Frazeysburg mine (see Goff, McGinnis, Millstead, McDonald mines); C.;

OHIO—Contiaued.

Muskingum county—Continued.

four samples: Fe,P. (239 f, 564 c); Goff mine (Frazeysburg); Coal Measures; described (239 c, 564 c). McDonald mine (Frazeysburg); Coal Measures; described (239 c, 564 c). McGinnis mine (Frazeysburg); Coal Measures; described (239 c, 564 c). Millstead mine (Frazeysburg); Coal Measures; described (239 c, 564 c).

Noble county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Perry county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55). Iron-ore mines: Bowman (farm) mine; C.; (blackband); two samples: Fe,P. (242 e, 564 b). Iron Point mine; C. and L.; (blackband); two samples: Fe,P. (242 e, 564 b). McLaughlin's Drift mine; Coal Measures; described (239 e); C.; two samples: Fe,P. (239 c, 564 c). Moxahala mine; C.; (blackband); two samples: Fe,P. (242 e, 564 c). Shawnee Furnace mine ("Pat Moore farm"); Coal Measures; described (239 f); C.; one sample: Fe,P. (239 f, 564 b).

Portage county. Coal (bituminous), statistics of the production of, in c. y, (662–665).

Scioto county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55). Iron-ore mines: Scioto Furnace mines; Coal Measures; described (239 c); C.; six samples: Fe,P. (239 c, 562 f).

Stark county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55).

Summit county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Trumbull county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55).

Tuscarawas county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55). Iron-ore mines: Anman Farm mine, near Dover; Coal Measures; described (240 a); C.; one sample: Fe,P. (240 a, 564 e). Bähler Farm mine; described; map (241); C.; (blackband); five samples: Fe, P. (242 b, 564 e). Dover Furnace Hill mine; C.; (blackband); two samples: Fe, P. (242 b, 564 e). Dover (near) mine; C.; one sample: Fe,P. (239 f, 564 e). Dye mine; C.; (blackband); three samples: Fe,P. (242 c, 564 f). Groeble Farm mine; C.; (blackband); one sample: Fe,P. (242 a, 564 e). Heit's Farm mine (rock ore), near Dover; Coal Measures; described (239 f); C.; one sample: Fe,P. (564 e). Hugh Kelley mine; C.; (blackband); four samples: Fe,P. (242 b, 564 f). Winkler's mine; C.; one sample: Fe,P. (241 a, 564 c). Wyan (farm) mine; C.; (blackband); two samples: Fe,P. (242 c, 564 f). Zoar Society mine, near Zoar; Coal Measures; described (240 a); C.; two samples: Fe,P. (240 a, 564 e).

Vinton county. Coal (bituminous), statistics of the production of, in c. y. (662–665). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 b); statistics of the production of iron ore in c. y. (52–55). Iron-mines: Burline (Eagle furnace) mine; H. (Coal Measures): one sample: Fe,P. (240 e, 564 b). Burline mines and Tan farm; L. and C.; two samples: Fe,P. (240 e, 564 b). Creola Furnace mines ("Dunkel ore"); Coal Measures; described (239 c); C.; one sample: Fe,P. (239 e, 564 b). Dunkel mine (see Creola furnace) (239 e, 564 b). Eagle furnace (Radclift district; C.?; one sample: Fe,P. (240 e, 564 b). Junction City mine; C.; two samples: Fe,P. (239 e, 564 c).

Washington county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Wayne county. Coal (bituminous), statistics of the production of, in c. y. (662–665).

Oil-stone. Statistics of the production of, by states and counties (844); by states (850–851).

OREGON.

Coal. Analysis of (788–789).

Iron. Amount in ore mined in c. y. and its per cent. of total iron in the United States' ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 d).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c, y.'s product and their per cent. of the amount and value of the United States' ore product (19 f, 74 e); aver.

OREGON—Continued.

Iron ore. Amount and value of c y.'s product, etc.—Continued.
age value per ton (19 d); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (25 c); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kindand grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b).

Iron ore. Statistics of the production of iron ore in c. y. (52–55, 64–69); general averages of these statistics (70, 71).

Iron ores. Partial analyses of (566–567).

Clackamas county. Iron ore: Amount of each kind of ore mined in, in the c. y. (25 c); statistics of the production of iron ore in, in c. y. (52–55). Iron-ore mines: Patton mine; L.; one sample: Fe,P. (497 c, 566 b). Prosser mine; described; section (16 f, 496 e); L.; two samples: Fe,P. (496 e, 566 a).

Oriskany limonites, character and position of the (15 a); in Pennsylvania (198 e); of Virginia (279 d).

Orton, Professor Edward. General section of Ohio Coal Measures (237); on horizon of crystalline carbonate ores ("Hudson ore") in Ohio (240 d); on the horizons of the ores of the Lower Coal Measures in Ohio (16 b).

P.

PENNSYLVANIA.

Barytes, statistics of the production of, in c. y. (839, 846–847).

Coal (anthracite), statistics of the production of, in c. y. (625–630, 650–651).

Coal (bituminous), statistics of the production of, in c. y. (666–669, 674–675).

Chromic iron, statistics of the production of, in c. y. (839, 846–847).

Cobalt, statistics of the production of, in c. y. (840, 846–847).

Copper, statistics of the production of, in c. y. (798–799).

Garnet, statistics of the production of, in c. y. (840, 846–847).

Glass-sand, statistics of the production of, in c. y. (840, 848–849).

Graphite, statistics of the production of, in c. y. (841, 848–849).

Hydraulic cement, statistics of the production of, in c. y. (841, 848–849).

Iron. Amount in ore mined in c. y. and its per cent. of total iron in the United States' ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 f).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the United States product (19 f, 74 e); average value per ton (19); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (25 c); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b); product of iron ore in c. y. and its value and the number of employés in the mines (75 d); royalty paid on each kind of ore mined in, in c. y. (32 c).

Iron ore. Statistics of the production of iron ore (52–59, 64–69); general averages of these statistics (70–71).

Iron ore. Bessemer; proportion of Bessemer to non-Bessemer ore produced in (20 e); amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e); proportion of Bessemer ore produced in (31 a).

Iron ores, partial analysis of (566, 567).

Iron ores: Archæan (6 e); magnetites, geological relations of the (11 e): magnetic ore, product of, in 1880 (12 a); Clinton hematite ores in (13 b); Second geological survey, ore beds of the Clinton group in Snyder county, according to (13 c); Oriskany ores in (15 a); limonite of the Hamilton shales in (15 b); "Red-ore bed" in (15 c); iron stones of the Coal Measures (15 e); relation of the iron product to the area of the ore-fields in (18 e).

Iron ores. Notes on the, of Pennsylvania compiled from the reports and unpublished material of the Second Geological Survey of Pennsylvania, J. P. Lesley, state geologist, and the Census Schedules, by Bayard T. Putnam, with geological *map* (Plate XXIX) showing position of iron mines (179–221). MAGNETITE (179 f). HEMATITE (180). LIMONITE.—Limonites of the Siluro-Cambrian formation; limonite ores in the Hudson river slates (Formation III) (197 f); limonite ores of the Medina formation (198 d); limonite ores of the Lower Helderberg and Oriskany formation (198 b, 199 d); limonite ores of the Devonian, chiefly of the Marcellus formation (199 e); limonite ores of the Mauch Chunk red shale (202 b). CARBONATE ORES.—Carbonate ores of the Siluro-Cambrian formation (202 d); carbonate

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Iron ores. Notes on the, etc.—Continued.
ores of the Marcellus formation (203 f); carbonate ores of the Pocono (?) formation (203 f); carbonate ores of the Mauch Chunk Red Shale formation (204 a); carbonate ores of the Pottsville conglomerate. Carbonate ores of the Coal Measures and their derivatives: A. Of the Lower Productive Coal Measures (Freeport, Kittanning, and Clarion Groups) (205 c); B. Of the Lower Barren Measures (210 c); C. Of the Upper Productive Measures (211 b); D. Of the Upper Barren Measures (partly Permian) (212 e). FOSSIL ORES of the Clinton formation (213 c); of the Chemung formation (219 e).

Iron ore. Report on certain magnetites, by Bailey Willis (223).

Lead and zinc, statistics of the production of, in c. y. (806).

Nickel, statistics of the production of, in c. y. (843, 850–851).

Soapstone, statistics of the production of, in c. y (845, 852–853).

Adams county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 c); statistics of the production of iron ore in c. y. (52–59); hematite ores of (181 a); Siluro-Cambrian limonite ores of (194 c). Iron-ore mines: Cole's (George) mine; H.; one sample: c. (181 a).

Allegheny county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in the c. y. (25 c); statistics of the production of iron ore in c. y (52–59).

Armstrong county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in the c. y. (25 c); statistics of the production of iron ore in c. y. (52–59); carbonate ores of Lower Productive Coal Measures of (206 b). Iron-ore mines: Stewardson Furnace mine; C.; six samples (206 f, 207 a). Pine Creek Furnace mine; C.; one sample: c. (207 a). Campbell and Barrett mine; c.; one sample: c. (207 a). Colwell (J. A.) mine; c.; one sample: c. (207 a). Brady's Bend (Iron Company) mine; C.; one sample: c. (207 b). Brown & Musgrove's mine; C.; one sample: c. (207 a).

Beaver county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Bedford county. Coal (bituminous), statistics of the production of, in c. y. (666–999). Iron ore: Amount of each kind of iron ore mined in the c. y. (25 c); statistics of the production of iron ore in c. y. (52–59). Siluro-Cambrian limonite ores of (197 d). Iron-ore mines: Baker's mine; L.: one sample: c. (197 e). Hoover (R.) mine; L.; one sample: c. (197 e).

Berks county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 c); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of, in c. y. (52–59). Siluro-Cambrian limonite ores of (186 a). Magnetic ore of (179 f, 180). Magnetite mines of (225 d). Iron-ore mines: Albright's (Joseph) Bank mine; L.; one sample: c. (186 e). Benfield Bank mine; L.; one sample; c. (186 e). Boyertown mines described; map of (230, 233). Brownbeck's (Frank) mine; one sample: c (186 e). Butz's mine; M.; one sample: Fe,S,P,SiO_2 (180 a). California mine, Boyertown; described; map; M.; two samples: Fe,P. (229 d, 566 c) Clymer Iron Company's mine; M.; one sample: Fe,Mn,P,SiO_2 (179 f, 180 a). Fleetwood Iron Company's mine; L.; one sample: C (186 a). Frederick's mine; M.; one sample: Fe,S,P,SiO_2 (180 a). Fritch & Brother's mine; M.; one sample: Fe,Mn, Al_2O_3,CaO,MgO,S,SiO_2 (180 a). Fritz Island mine, near Reading; described; M.; one sample: Fe,P. (229 e, 566 c). Gable mine, Boyertown; M.; one sample: Fe,P. (229 d, 566 c); described (233 c). Geary's (Charles) mine (Rittenhouse gap); M.; one sample: Fe,S,P,SiO_2 (180 a). Greiss & Wendlings mine; M.; one sample: Fe,S,P,SiO_2 (180 a). Guiterman's mine; one sample: Fe,Mn,Al_2O_3,CaO,MgO,S,P,SiO_2 (180 a). Haines & Klutz's mine; M.; one sample: Fe, S, P, SiO_2 (180 a). Heffner's (Charles) mine; L.; one sample: C. (186 a). Jones' mine, near Springfield; described; section; M.; two samples: Fe,P, (225 d, 566 d). Kline's (D. K.) mine; L.; one sample: c. (186 a). Lewis' (Samuel) mine; L.; one sample: c. (186 a). Merkel's (Mrs. John) mine; L.; one sample: c. (186 a). Miller's (Charles) mine; L.; one sample: c. (186 a). Miller's (William) mine; L.; one sample: c. (186 a). Moselem Bank mine; L.; three samples: c. (186e). Phœnix mines, Boyertown; described, map (229 e, 230). Phœnix mine; M.; one sample: Fe,P. (229 d, 566 c). Rowe's mine; M.; one sample: Fe,P. (566 c). Shaefer mine; L.; one sample: C. (186 e). Smyer's (D. H.) Heirs' mine; L.; one sample: C. (186 a). Tatham Brothers' mine; M.; one sample: Fe,Al_2O_3,CaO,MgO,S,P,SiO_2 (180 a). Trexler's (E. H.) mine; L.; one sample: C. (186 a). Udree mine; L.; one sample: C. (186 a). Warwick mine, Boyertown, described; map (230–232); M.; one sample: FeP. (231 a to 233, 566 c). Weiler (Dankle) mine; L.; one sample: C (186 e). Wheatfield mine (near Reading); described; section (228 e); M.; one sample: Fe,P. (229 b, 566 c). Ziegler's (David) mine; L.; one sample: c. (186 a). Ziegler's (Jonathan) mine; L.; one sample: c (186 a).

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Blair county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 c); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); Clinton ores of (219 a); statistics of the production of, in c. y. (52–59); Siluro-Cambrian limonite ores of (195 c, 196, 197); occurrence of limonite in the Lower Helderberg limestone (13 f). Iron-ore mines: Baker's mine (Blair furnace); L.; four samples: c. (198 f, 199 b). Bloomfield mines; L.; five samples: three c.; two Fe,Mn,S,P,Al,CaO,MgO,SiO_2 (196 e, 197 a). Brower mine; L.; one sample: c. (196 b). Clark Farm mine; L.; one sample: c. (195 f). Dean's mine; L.; one sample: C. (196 c). Etna furnace mine; L.; one sample: c. (195 f). Falkner mine; L.; one sample: c. (195 f). Henrietta mines; L.; one sample: c. (195 e). Hollidaysburg mine; F.; two samples: c. (219 c). Hollidaysburg and Gap Iron Company's mine; F.; two samples: c. (219 d). Hoover mine; L.; one sample: c. (195 f). McPheese mine; L.; one sample: c. (196 d). Patterson mine; L.; one sample: c. (196 b). Rebecca mine; L.; one sample; c. (196 d). Red Bank mine; L.; one sample: c. (196 c). Red Ore mine; L.; one sample: c. (196 d). Robeson Farm mine; L.; one sample: c. (195 f). Sarah Furnace mine; L.; two samples: c. (196 d). Sarah Furnace mine; F.; one sample: c. (219 e). Short Mountain mines; L.; one sample: c. (195 f). Soister mine; L.; one sample: c. (196 d). Springfield mines; L.; four samples: c. (196 c). Thompson mine; L.; one sample: c. (196 d).

Bradford county. Coal (bituminous), statistics of the production of, in c. y. (666–668).

Bucks county. Iron ore, statistics of production of, in c. y. (52–59).

Butler county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in the c. y. (25 c); statistics of the production of iron ore in c. y. (52–59). Carbonate ores of Lower Productive Coal Measures of (207 b). Iron-ore mines: Denny's mill mine; C.; one sample: c. (207 c).

Cambria county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Cameron county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Carbon county. Coal (anthracite), statistics of the production of, in c. y. (625–630). Iron ore: Amount of each kind of iron ore mined in c. y. (25 c); statistics of the production of, in c. y. (52–59); carbonate ores of (204).

Centre county. Coal (bituminous), statistics of the production of in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in c. y. (25 c); statistics of the production of iron ore in c. y. (52–59). Siluro-Cambrian ores of (195 a). Iron-ore mines: Fishing Creek mine (Curtin Brothers); L.; one sample: c. (195 b). Howard mine; L.; one sample: c. (195 c).

Chester county. Iron ore: Amount of each kind of ore mined in, in the c. y. (25 c); statistics of the production of iron ore in c. y. (56–59). Siluro-Cambrian limonite ores of (193 e). Iron-ore mines: French Creek mines described (225 b, 231 e, 233 f); M.; two samples: Fe,P (233 d, 566 d). Hopewell mine, near Saint Mary's, described (234); M.; one sample: Fe,P. (234 a). Saint Mary, mines near (225 b, 234 a).

Clarion county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in c. y. (25 c); statistics of the production of iron ore in c. y. (56–59). Carbonate ores of, Lower Productive Coal Measures of (207 d). Iron-ore mines Fox farm: mine; C.; one sample: c. (207 f). Hindman's mine; C.; one sample: c. (207 f). Sligo Furnace mine; C.; one sample: c. (207 f).

Clearfield county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Clinton county. Coal (bituminous), statistics of the production of, in c. y. (666–669); Siluro-Cambrian limonite ores of (194 e). Iron-ore mines: Salona mine; L.; two samples: c. (194 f).

Columbia county. Coal (anthracite), statistics of the production of, in c. y. (625–630). Iron ore: Amount of each kind of ore mined in, in the c. y. (25 d); statistics of the production of iron ore in c. y. (56–59). Clinton ores of (213 c).

Crawford county. Cussewago township the center of total iron-ore production of the United States (37 c).

Cumberland county. Iron ore: Amount of each kind of ore mined in, in c. y. (25 d); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); Siluro-Cambrian limonite ores of (188 a, 190 a); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Ahl's (Carey) bank; L.; one sample: c. (10 a). Bear's bank; L.; one sample: c. (190 a). Beltzhoover bank; L.; two samples: c. (188 f). Best's bank; L.; one sample: c. (190 a). Big Pond bank; L.; one sample: c. (188 b). Bridge's (John) opening; L.; one sample: c. (188 b). Calico mine; L.; two samples: c. (188 b). Chestnut bank; L.;

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one sample: c. (188 b). Clay (Henry) bank, (Nos. 1, 2, and 3); L.; four samples: c. (188 d). Clever Mammoth bank (No. 1); L.; one sample: c. (188 b). Clever (George) bank; L.; one sample: c. (188 b). George H. Clever bank; L.; one sample: c. (188 b). Cressler's (John H.) bank; L.; one sample: c. (188 b). Divon tract: L.; one sample: c. (188 d). Ege bank; L.; two samples: c. (188 f). Gorgas bank; L.; one sample; c. (190 a). Grove bank; L.; two samples: c. (188 d, 188 f). Heike's bank; L.; one sample: c. (190 a). Koontz & Myers mine; L.; one sample: c. (188 d). Laurel mines (Nos. 1 and 2); L.; two samples: c. (188 d). Lehman (J. C.) Bank No. 2: L.; one sample: c. (188 f). Leidig & Hoffer bank; L.; one sample: c. (188 f). McCreechan's bank; L.; one sample: c. (190a). Mount Holly bank; L.; two samples: c. (188). Mullen's (Charles) bank; L.; one sample: C. (190 a). Mullen bank; L.; one sample: c. (188 f). Myer's bank; L.; one sample: c. (190 a). Old Peach Orchard mine; L.; one sample: c. (188 b). Peffer bank; L.; one sample: c. (188 b). Pepper bank; L.; one sample: c. (188 f). Pine Grove mine; L.; one sample: c. (188 d). Raapp bank; L.; one sample: c. (190 a). Shopp bank; L.; one sample: c. (190 a). Strickler bank; L.; one sample: c. (188 f). Weaver mine; L.; one sample: c. (190 a). Wild Cat opening; L.; one sample: c. (188 d). Woods (Sterrett) bank; L.; one sample: c. (190 a).

Dauphin county. Coal (anthracite), statistics of the production of, in c. y. (625–630). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 d); statistics of the production of iron ore in c. y. (56–59). Siluro-Cambrian limonite ores of (187 d). Iron-ore mines: Derry mine; L.; one sample: c. (187 e). Swatara mine; L.; one sample: c. (137 e).

Delaware county. Garnet, statistics of the production of, in c. y. (840).

Elk county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Fayette county. Coal (bituminous), statistics of the production of, in c. y (666–669). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 d); statistics of the production of iron ore in c. y. (56–59); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); carbonate ores of the Mauch Chunk red shale (204 c); carbonate ores of Lower Productive Coal Measures of (208 a); carbonate ores of Upper Productive Measures of (Pittsburgh coal horizon) (15 f, 211 b). Iron-ore mines: Center Furnace mines; C.; two samples: Fe, S,P,SiO_2 (204 f). Fayette Furnace mine; C.; two samples: Fe,S,P,SiO_2 (208 b). Fuller's (Dr.) mine; C.; one sample: c. (211 e). Hoggsett, Watt and Co.'s mine; C.; three samples: Fe,S,P,CaO,MgO,SiO_2 (212 d). Lemont mines; seven samples: Fe,S,P,SiO_2; one sample, c. (204 c, 212 b). Magiffin (J. S.) mine; C.; one sample: c. (208 d). Oliphant Furnace mine; C.; two samples: c. (211 f, 212 a). Vernon mines; c.; two samples: Fe,S,P,SiO_2 (204 c).

Franklin county. Barytes, statistics of the production of, in c. y. (839). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 d); statistics of the production of iron ore in c. y. (56–59). Devonian limonite ores of (202 c); Siluro-Cambrian limonite ores of (190 d, 191, 192). Iron-ore mines: Ahl's mine; L.; one sample: c. (193 a). Beaver mine; L.; one sample: c. (192 c). Bower's Furnace mine; L.; one sample: c. (202 b). Calliman (Thomas) mine; L.; one sample: c. (193 a). Chamber's (William L.) mine; L.; one sample: c. (193 d). Cressler (Joseph) mine; L.; one sample: c. (193 d). Douglass (Wyeth) mine; L.; one sample: c. (192 e). English mine; L.; one sample; c. (193 b). Garlick mine; L.; one sample: c. (192 d). George (Benjamin) mine; L.; one sample: c. (192 f). Gochenaner and Rohrer mine; L.; one sample: c. (193 e). Good's (Michael) ore-bank; L.; two samples: c. (19 e). Guilford mine; L.; one sample: c. (193 c). Hope mine (Mont Alto Iron Company); L.; one sample: c. (193 c). Jones' (Jennings) mine; L.; one sample: c. (192 c). Koser (Jacob) mine; L.; one sample: c. (193 d). Leib mine (J. S. Whitmer & Co); L.; one sample: c. (198 c). Lime Kiln mine; L.; one sample: c. (193 b). Lucy mine (Mont Alto Iron Company); L.; one sample: Fe,P. (191 e). McCleary's (Robert) mine; L.; one sample: c. (192 d). McFarland's (R. P.) mine; L.; one sample: c. (198 c). McHose mine; one sample: c. (193 d). McNeal mine (McCormick & Co); L.; one sample: L.; (193 a). Means mine; L.; one sample: c. (193 e). Mentzer (David) mine; L.; (192 e). Mont Alto Iron Company's mines; L.; five samples: c. (192 e, 193 a). Old Carrick Furnace mine; L.; two samples: c. (192 c). Old Mount Pleasant mine; L.; one sample: c. (192 b). Old Southampton mine; L.; one sample: c. (193 e). Pass Orchard mine; L.; one sample: c. (192 d). Pond mines, Nos. 1 and 2; L.; two samples: c. (193 b). Promise mine (Mont Alto Iron Company); L.; one sample: c. (193 c). Railroad mine; L.; one sample: c. (192 c). Richmond Furnace mine; L.; one sample: c. (198 c). Rock's (George) mine; L.; one sample: c. (192 d). Rock's (Jacob) mine; L.; one sample: c. (193 a). Ruby or Plas-

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ter mine; L.; one sample: c. (193 e). Ruth mine; L.; one sample: Fe,P. (191 e). Small (John) mine; L.; one sample: C. (192 f). Smith, Duncan and Avery's mine (see Webster mine); L.; one sample: c. (192 e). Stinger's (Squire) mine; L.; one sample: c. (192 d). Stouffer's (Jacob) mine; L.; one sample: c. (198 c). Webster mine (Smith, Duncan and Avery); L.; one sample: c. (192 d). Weinman's (George) mine; L.; one sample: c. (192 c). White Rock mine (Mont Alto Iron Company); L.; one sample: c. (193 c). Wiestling mine; L.; one sample: c. (193 d). Soapstone, statistics of the production of, in c y. (845).

Fulton county. Devonian limonite ores of (201 c). Iron-ore mines: Awl (P.) & Bro.'s mine; L.; one sample: C. (201 e).

Greene county. Coal (bituminous), statistics of the production of in, c. y. (666–669).

Huntingdon county. Coal (bituminous), statistics of the production of, in, in c. y. (666–669). Glass-sand, statistics of the production of, in c. y. (840). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25d); statistics of the production of iron ore in c. y. (56–59). Clinton ores of (217 e); Devonian limonite ores of (200 d); Siluro-Cambrian limonite ores of (195 c). Iron-ore mines: Blacklog Gap (near Orbisonia) mine; F.; two samples: Fe,S,P,CaO,MgO,SiO_2 (218 b). Blacklog Gap (south side of) mine; F.; two samples: c. (218 a). Blacklog Mountain mine; L.; surface ore; one sample: Fe,Mn,S,P,SiO_2 (198 e). Diggin's (Jos.) mine; L.; one sample: Fe,S,P,SiO_2 (202 c). Douglass mine; L.; one sample: Fe,S,P, SiO_2 (200 f). Dull and Bradley's mine; F.; two samples: c. (218 f). Greenwood furnace (4 miles from) mine; F.; one sample: c. 218 d). Hick's mine; L.; one sample: Fe,S,P,SiO_2 (200 e). Lane mine; L.; one sample: Fe,S,P,SiO_2 (200 e). McAleavy's Fort mine; F.; two samples: Fe,S,P,CaO,MgO,SiO_2 (218 b). McCarthy's mine; L. and C.; one sample: c. (201 c). Mountain mine; L.; one sample: Fe,S,P,SiO_2 (200 f). Ramsey's (Alexander) property; L.; surface ore; one sample: Fe, Mn,S,P,SiO_2 (198 e). Sandy Ridge mine; L.; one sample: Fe,S,P,SiO_2 (200 f). Shade (Dr. J. A.) mine; L.; one sample: c (201 c). Stambach's (William) mine; L.; one sample: Fe,Mn,S,P,SiO_2 (198 e). Taylor (Isaac) mine; L.; one sample: c. (201 c).

Indiana county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Jefferson county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Juniata county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 d); statistics of the production of iron ore in c. y. (56–59). Clinton ores of (216 d); Devonian limonite ores of (200 c). Iron ore mines: Aughey (Henry) mine; F.; one sample: Fe,S,P,SiO_2 (216 e). Aughey (Samuel) mine; F.; one sample: Fe,S,P,SiO_2 (216 e). Graham mine (Nos. 1, 2, and 3); F.; three samples: Fe,S,P,SiO_2 (216 e). Hirsh and Hiestand mine; F.; one sample: Fe,S,P,SiO_2 (216 e). Hankwell (Richard) mine; F.; one sample: Fe,S,P,SiO_2 (217 a). Hankwell (William) mine; F.; four samples: Fe,S,P,CaO,MnO,SiO_2,(217 a). Robinson (land of John), Licking Creek valley; F.; one sample: c (217 b).

McKean county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Lackawanna county. Coal (anthracite), statistics of the production of, in c. y. (625–630).

Lancaster county. Chromic iron, statistics of the production of, in c. y. (839). Cobalt, statistics of the production of, in c. y. (840). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 d); rank among counties producing less than 100,000 tons and over 50,000 tons of iron ore (75 b); Statistics of the production of iron ore in, in c. y. (56–59). Siluro-Cambrian limonite ores of (193 e). Iron-ore mines: Chestnut Hill mines; L.; five samples: c. (194 a). Nickel, statistics of the production of, in c. y. (843).

Lawrence county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Hydraulic cement, statistics of the production of, in c. y. (841). Iron ore: Amount of each kind of iron ore mined in the c. y. (25 d); statistics of the production of iron ore in c. y. (56–59). Carbonate ores of Lower Productive Coal measures of (208 d). Iron-ore mines: Houck and Granniss's mine; C.; three samples: c. (209 a). Neshannock mine; C.; one sample: Fe,Mn,S,P,CaO,MgO. (205 c). New Castle mine; C.; one sample: Fe,Mn,S,P,CaO,MgO. (205 c). Rose Point mine; C.; two samples: c. (208 f). Ziegler's mine; C.; two samples: c. (209 b).

Lebanon county. Iron ore: Amount of each kind of iron ore mined in the c. y. (25 d); rank among counties producing over 100,000 tons of iron ore in c. y. (75 a); statistics of the production of iron ore in, in c. y. (56–59); magnetite mines of (226); Siluro-Cambrian limonite ores of (187 a). Iron-ore mines: Big Hill (Cornwall) mine; trap-dyke; described; sec-

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Talc. Statistics of the production of, by states and counties (845); by states (852–853).

TENNESSEE.

Coal (bituminous), statistics of the production of, in c. y. (666–669, 674–675).

Copper ore, statistics of the production of, in c. y. (798–799).

Iron. Amount in ore mined in c. y. and its per cent. of total ore in United States' ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 f).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 f); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (25 f); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b); royalty paid on each kind of ore mined in, in c. y. (32 c).

Iron ore. Statistics of the production of iron ore in c. y. (56–59, 64–69); general averages of these statistics (70–71).

Iron ore. Bessemer, amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e).

Iron ores. Complete analyses of (596–599); partial analyses of (566–573).

Iron ores. Limonites, belts of (10 d); occurrence of the Clinton ores (13 d); character of the iron ore in the Devonian shales (15 b); residuary limonite (15 c).

Iron ores. Notes on the samples of iron ore collected in, by Bailey Willis (331–350); iron ore sample *map* of Tennessee and North Carolina (geologically colored) (Plate XXXV). LIMONITES.—Polk county (331); McMinn county (332); Monroe county (332); Blount county (334); Sevier county (335); Cocke county (336); Hamblen county (336); Greene county (337); Washington and Union counties (338); Carter and Johnson counties, *map* of, and parts of adjacent counties (340); Sullivan county (345). SPECULAR ORES (346). DYESTONE ORES.—*Map* of portions of Anderson, Campbell, and Scott counties, showing deposits of fossil ore; sampled (348).

Iron ores. Notes on the samples of iron ore collected in, by W. M. Chauvenet (351–365); *map* of Tennessee showing the iron region in (352). FOSSIL ORES.—*Map* of the valley of East Tennessee, showing ranges of fossil ores; James county (351); Bradley county (353); Rhea county (354); Meigs county (355); Roane county (357); *map* of the iron region of western Tennessee. LIMONITES.—Lawrence county (357); Wayne county (359 a); Decatur county (359); Perry county (359); Hickman county (360 c); Dickson county (360); Montgomery county (362); Stewart county (363).

Lead and zinc ore, statistics of the production of, in c. y. (804–805, 806).

Anderson county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron-ore mines: Clear Branch mine; F.; one sample: Fe,P. (349 a, 570 d). Lone Mountain mine; F.; one sample; Fe,P. (349 a, 568 f).

Blount county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in c. y. (56–59); Lower Silurian limonite ores of (334 b). Iron-ore mines: Abram's Creek mine; Lower Silurian; described (334 c); L.; one sample: Fe,P. (334 d, 568 e). Cade's Cove mine (land of William Feezelle); Lower Silurian; described (334 c); L.; one sample: Fe,P. (334 c, 568 e); Carpenter mine; Lower Silurian; described (335 a); L.; one sample: Fe,P,S. (335 a, 568 f). Flat

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Blount county—Continued.

o the Mountain mine; Lower Silurian; described (334 d); L.; one sample: Fe,P,Mn. (334 d, 568 f). Kerr's (widow) mine; Lower Silurian; described (335 b); L.; one sample: Fe,P,S. (335 b, 568 f). Mount mine; L.; one sample: Fe,P. (568 f). Razer mine; Lower Silurian; described (334 d); L.; one sample: Fe,P. (334 d, 568 e). Seaton mine; Lower Silurian; described (335 a); L.; one sample: Fe,P,S. (335 a, 568 f). Wilson mine; Lower Silurian; described (335 a); L.; one sample: c.; one sample: Fe,P,S. (335 a, 568 f, 597).

Bradley county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Hinch's mine; F.; one sample: Fe,P. (353 d, 566 f). Smith mine; F.; one sample: Fe,P. (353 c, 566 f).

Campbell county. Coal (bituminous), statistics of the production of, in c. y. (666–669); Scott, and Anderson counties, map of portion of (348). Iron-ore mine: Big Creek Gap mine; F.; one sample: Fe,P. (349 b, 570 d).

Carter county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in c. y. (56–59); and Johnson, and parts of adjacent counties, map of (340); and Johnson counties, Lower Silurian limonite and manganese ores of (339 d). Iron-ore mines: Bear Wallow mine; Lower Silurian (340 f). Blevins mine, Stony creek; Lower Silurian; described (345 b); one sample: Fe,P,Mn (344 d, 572 e). Cannon mine; Lower Silurian; described (345 b); H. (s); one sample: Fe,P. (345 b, 346 e, 347 a, 572 d). Carden's (Wesley) mine; Lower Silurian; described (341 d); L.; one sample: Fe,P. (341 d, 572 c). Cedar Hill mine; Lower Silurian; described (340 f); L.; one sample; Fe,P. (340 f, 341 b, 572 c). Duggers mine; Lower Silurian; described (345 b); L.; one sample: Fe.P. (345 b, 572 c). Ferguson mine; Lower Silurian; described (345 c); L.; one sample: Fe,P. (345 a, 572 c). Hodge mine; Lower Silurian; described (345 a); L.; one sample: c. (345 a, 572 c, 599). Hurley mine; Lower Silurian; described (345 b); L.; one sample: Fe,P. (345 b, 572 c). Jips mine; Lower Silurian; described (345 a); L.; one sample: Fe,P. (345 a, 572 c). Maxwell mine; Lower Silurian; described (345 b); H. (s); one sample; Fe,P. (345 b, 347 a, 572 c). Queen's Station mine; Lower Silurian; described (341 a); L.; one sample: c. (341 a, 572 c, 598). Red Shear mine; Lower Silurian; described (345 a); L.; one sample: Fe,P. (345 a, 572 d). Specular mine; Lower Silurian; described (345 a); L. and H. (s); one sample: C. (345 a, 572 c, 599). Taylor mine; Lower Silurian; described (344 f); L.; one sample: c. (344 f, 345 c, 572 c, 599).

Claiborne county. Lead and zinc, statistics of the production of, in c. y. (804–805).

Cocke county. Iron ores: Lower Silurian; limonite ores of (336 b). Iron-ore mines: Mantooth's (James) (see Mine ridge) (570 f). Mine Ridge mine (see Mantooth); Lower Silurian; described (336 c); L.; one sample; Fe,P. (336 d, 570 f). Smith's mine (Major W. R.); H. (s); one sample, c. (347 c, 570 f, 597). Southern States Coal, Iron, and Land Company's mine (see Wolf creek); Lower Silurian; described (336 d); L.; one sample: Fe,P. (336 d, 570 f). Wolf Creek mine (336 d, 570 f).

Cumberland county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Decatur county. Iron-ore mines: Brownsport furnace; one sample: Fe,P. (359 f, 360 a, 570 a). Decatur furnace; L.; one sample: Fe,P. (359 e, 568 f).

Dickson county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in, in c. y. (56–59). Iron-ore mines: Bell mine; L.; one sample: Fe,P. (361 e, 362 a, 570 b). Boston mine; L.; one sample: Fe,P. (361 f, 362 a, 570 c). Cumberland furnace banks (see Bell, Dry Hollow, Nye, Burton, Henry Drake, and Red Banks) (361 a, 262 b, 570 b). Henry Drake mine; L.; one sample: Fe,P. (361 f, 362 a, 570 b). Nye mine; L.; one sample: Fe,P. (361 f, 362 a, 570 b). Piney Furnace mine; L.; two samples: Fe,P. (360 f, 361 a, 570 b). Red mine; L.; one sample: Fe,P. (361 f, 362 a, 570 b). Worley furnace; L.; two samples: Fe,P. (361 b, 570 b).

Franklin county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Greene county. Lower Silurian limonite ores of (337 a). Iron-ore mines: Camp Creek forge (George Babb's land); one sample: Fe,P. (337 e, 570 f). Greene Ridge mine; Lower Silurian; described (337 a); L.; two samples; Fe,P. (337 d, 570 f). Lamb mine; Lower Silurian; described (337 a); L.; one sample: Fe,P. (337 a, 570 f). Stephens mine; Lower Silurian; described (337 a); L.; one sample: Fe,Mn. (337 a, 570 f). Varner mine; Lower Silurian; described (337 a); L.; one sample: Fe,P. (337 a, 570 f).

Grundy county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore, amount of each kind of iron ore mined in, in the c. y. (25 f).

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Hamblen county. Iron ore: Statistics of the production of, in c. y. (56–59). Lower Silurian limonite ores of (336 e). Iron-ore mines: Vineyard mine; Lower Silurian; described (336 e); L.; one sample: Fe,P. (336 f, 570 e). Williams mine; Lower Silurian; described (336 e); L.; one sample: Fe,P. (336 f, 570 e).

Hamilton county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore mines: Chattanooga (1½ mile south of); F.; two samples: Fe,P. (354 c, 568 a). Coker mine (Clift and Sawyers); Clinton; described; section (353 c); F.; two samples: Fe,P. (353 f, 354 a, 568 a). Lowe's mine; F.; two samples: Fe,P. (568 a).

Hickman county. Iron-ore mines: Ætna mine; L.; one sample: Fe,P. (360 d, 570 a). Old Mill Creek furnace; L.; one sample: Fe,P. (360 e, 570 b).

James county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in, in c. y. (56–59). Iron-ore mines: Burns' mine; F.; one sample: Fe,P. (566 f). Green's mine; F.; three samples: Fe,P. (353 a, 566 f). Ragon's mine; described; section (351 f, 353); F.; one sample: Fe,P. (566 f).

Jefferson county. Lead and zinc ore, statistics of the production of, in c. y. (804–805).

Johnson county. Iron ore: Amount of each kind of ore mined in, in the c. y. (25 f). Iron ore: Statistics of the production of iron ore, in c. y. (56–59). And Carter and parts of adjacent counties; map (340). And Carter counties; Lower Silurian limonite ores of (339 d). Iron-ore mines: Baker mine; Lower Silurian; described (343 f); L.; one sample: c. (343 b, 572 e, 598). Blevin's (Armstead) mine; Lower Silurian; described (344 d). Blevin's (Armstead) mine; L.; one sample: Fe,P. (345 b, 572 c). Brown's forge (see Songa Hollow mine) (342 f, 572 e). Butler's mine; Lower Silurian; described (343 f); L.; one sample: Fe,P. (344 a, 572 e). Cove mine; Lower Silurian; described (343 f); L.; one sample: Fe,P. (343 b, 572 e). Cross Mountain mine; H.(s).; one sample: Fe,P. (572 e). Donnelly's mine; Lower Silurian; described (343 f); L.; one sample: Fe,P. (343 f, 572 e). Dugger (John) mine; Lower Silurian; described (343 b). Far Mountain mine; Lower Silurian; described (342 d); L.; one sample: Fe,P. (342 d, 572 d). Ground-Hog mine; Lower Silurian (342 d). King mine; Lower Silurian; described (344 d); one sample: Fe,P,Mn. (344 d, 572 f). Laurel Fork mine; Lower Silurian; described (344 d); L.; one sample: Fe,P. (344 b, 572 e). Mast mine; Lower Silurian; described (343 a); L.; one sample: Fe,P. (343 a, 572 e). Near Mountain mine; Lower Silurian; described (342 d); L; one sample: Fe,P. (342 d, 572 d). Rankine's mine; Lower Silurian; described (342 c); L.; one sample: Fe,P. (342 c, 572 d). Road Hollow mine; Lower Silurian; described (343 b). Stout's mine; Lower Silurian: described (342 c): Silver mine; Lower Silurian; described (344 d). Songa Hollow (Brown's forge) mine; Lower Silurian; described (342 f); L.; one sample: Fe,P. (342 f, 572 e). Stout's mine; L.; one sample: Fe,P. (342 c, 572 d). Taylor's mine; Lower Silurian; L.; one sample: Fe,P. (343 b 572 e). Tompkins mine; Lower Silurian; described (342 d); L.; one sample: Fe,P. (342 d, 572 d). Wash Place mine; Lower Silurian; described (341 f); L.; one sample: c. (341 f, 342 a, 572 d, 598).

Knox county. Iron-ore mine: Peters and Mowry; one sample: Fe,P. (350 f, 568 f). Lead and zinc, statistics of the production of, in c. y. (804–805).

Lawrence county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (25 f); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Davis mine (see Napier's furnace); L.; one sample: Fe,P. (358 a, 568 c). Lawrenceburg (6 miles southwest of); L.; one sample: Fe,P. (357 f, 568 c). Napier's furnace (see Davis and Pinion mines (358 a, 568 c). Pinion mine (see Napier's furnace; Lower Silurian; described; sketch of a pot of limonite from (358 a); L.; two samples: one, Fe,P., one c. (358 a, 368 c, 596).

Marion county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

McMinn county. Iron ores: Lower Silurian limonite ores of (332 c). Iron-ore mines: Burke's (Sheriff William) mine; H. (s); one sample: Fe,P. (346, 347, 568 d). Cates' (Charles) mine; Lower Silurian; described (332 d); L.; one sample: Fe,P,S (332 d, 568 d). Hill's mine; Clinton (332 e); F.; one sample: Fe,P. (350 d, 568 d). Patty's (R. G.) mine; Lower Silurian; described (332 d); L.; one sample: Fe,P,S. (332 c, 568 d). Stonedye mine; Archæan (332 e); one sample: Fe,P. (346 f, 347 a, 568 e).

Meigs county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of, in c. y. (56–59). Iron-ore mine: Kendrick's mine; F.; one sample: Fe,P. (355 d, 568 b).

Monroe county. Lower Silurian limonite ores of (332 f). Iron-ore mines: Anderson's mine; Lower Silurian; L.; one sample: Fe,P,Mn. (334 a, 568 e). Curd's mine, near Jalapa; Lower Silurian; described (333 a); L.; one sample: Fe,P. (333 a, 568 e). Donnelly's mine; Lower Silurian; described (333 e); L.; one sample: Fe,P,Mn. (333 e, 568 e). Griffith's (Jerome) mine; Lower Silurian; described (332 f); L.; one sample: Fe,P. (332 f, 333 a, 568 e). Hale mine; Lower Silurian; described (333 b); L.; one sample: c. (333 b, 568 e, 597). Tellico mine; Lower Silurian; described (333 e); L.; one sample: Fe,P,Mn (333 f, 568 e).

Montgomery county. Iron-ore mines: Bryan's mine; L.; one sample: Fe,P. (362 e, 570 d). Poplar Springs mine; L.; one sample: Fe,P. (363 a, 570 d). Steel's mine; L.; one sample: Fe,P. (362 d, 570 d). Vernon furnace; L.; one sample: Fe,P. (362 c, 570 d).

Perry county. Iron-ore mines: Cedar Grove furnace; L.; one sample: Fe,P. (360 b).

Polk county. Iron ore, Lower Silurian limonite ores of (331 d). Copper, statistics of the production of, in c. y. (798–799). Iron-ore mines: Ducktown mine; Archæan; described (331 e); L.; two samples: Fe,P,Cu (331 d, 568 d). Gee Creek Gap mine; Lower Silurian; described (332 b); L.; two samples: Fe,P. (332 b, 568 d). Loud[illegible] mine; Archæan; described (331 f); L.; one sample: Fe,P,Cu (331 e, 568 d).

Rhea county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (25 f); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Hill and Tarwater mine; Clinton; described; section; plan (354 c); F.; three samples: one c. (354 d, 355 a, 568 c, 596).

Roane county. Coal (bituminous), statistics of the production of, in c. y. (666–669). Iron ore: Amount of each kind of iron ore mined in, in c. y. (25 f); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Brown's mine; F.; two samples: Fe,P. (355 e, 568 b). Oakdale Furnace mine (see Solomon's mine). Piatt's mine; Clinton; described; section (356 b); F.; two samples: Fe,P. (356 c, 568 b). Roberts (J. D.) mine (see Welcker, B. F.) (356 a, 568 b). Solomon's (Oakdale furnace) mine; F.; two samples: Fe,P. (357 a, 568 b). Welcker's (B. F.) property (see J. D. Roberts); F.; two samples: Fe,P. (356 a, 568 b).

Scott county. David's, Widow mine; Clinton; described; section (349 d 350 a); F.; one sample: Fe,P. (349 e, 570 e). Stanfield's (Lewis) mine; F.; three samples: Fe,P. (349 e, 570 e).

Sevier county. Lower Silurian limonite ores of (335 f). Iron-ore mines: Love's Furnace mine; Lower Silurian; described (335 f, 336 a); L. and M.; two samples: Fe,P. (335 f, 336 a, 570 e). Newman's mine; Lower Silurian; described (335 f); L.; one sample: Fe,P. (335 f, 336 b, 570 b).

Stewart county. Iron ore: Amount of each kind of iron ore mined in the c. y. (25 f); statistics of the production of iron ore in c. y. (56–59). Iron-ore mines: Banagan and Shurlock mine; L.; one sample: Fe,P. (364 f, 570 c). Bear Springs furnace; L.; one sample: Fe,P. (364 c, 570 c). Bellwood mine; L.; two samples: Fe,P. (364 a, 570 c). Clark Furnace mines; L.; one sample: Fe,P. (364 d, 570 c). East Bellwood mine; L.; one sample: Fe,P. (364 b, 570 c). Fig and Bayley mine; L.; one sample: Fe,P. (364 f, 570 c). Graveyard mine; L.; one sample: Fe,P. (364 b, 570 c). La Grange mine; L.; one sample: c.; one sample: Fe,P. (364 e, 365 a, 570 c, 597). Mound mine; L.; one sample: Fe,P.; one sample: c. (363 d, 570 c, 597). Outlaw (E. C.); L.; one sample: C. (363 e, 570 d). Pipe mine (Clark furnace); L. (pipe); one sample: Fe,P. (364 c, 570 c). Race mine; L.; one sample: Fe,P. (364 b, 570 c). Rough and Ready furnace; L.; one sample: Fe,P. (363 b, 570 c). Sheridan mine; L.; one sample: c.; one sample: Fe,P. (364 e, 365 a, 570 c, 597). West Bellwood mine; L.; one sample: Fe,P. (364 b, 570 c).

Sullivan county. Iron-ore mines: Crockett mine; H. (s); one sample: Fe,P,S. (345 f, 572 f). Sharp mine; M.; one sample: c. (346 a, 572 f, 598).

Unicoi county. Iron ore: Lower Silurian limonite of (338 a). Iron-ore mines: Big mine; L.; one sample: Fe,P. (572 b). Blue Springs mine; Lower Silurian; described (339 a); L.; one sample: Fe,P. (339 a, 572 b). Casper mine; Lower Silurian; described (338 f); L.; one sample: Fe,P. (338 f, 339 a, 572 f). Embreeville Furnace (Cold short) mine; Lower Silurian; L.; one sample: Fe,P. (338 d, 572 b). Hamum's (Dr.) mine; L.; one sample: Fe,P. (572 b). Keener mine; L.; one sample: Fe,P. (572 b).

Union county. Lead and zinc ore, statistics of the production of, in c. y. (804, 805).

Washington county. Iron ore: Lower Silurian limonite of (338 a). Iron-ore mines: Bompass Cove (lead) mine; Lower Silurian described (338 a). Bompass Cove (main bank) mine; Lower Silurian; described (338 a). Huffine's mine; Lower Silurian; described (339 c); L.; one sample: Fe,P. (339 c, 572 a). Lead mine (Bomspass cove); Lower Silurian; described (338 a); L.; one sample: Fe,P. (338 e, 572 b). Main bank; L.; one sample; Fe,P. (338 e, 572 b).

Wayne county. Iron-ore mines: Marion furnace mines (see Red mine and White mine). Red mine; L.; one sample: c. (see Marion furnace) (359 c, 568 c, 597). Wayne Furnace mine; L.; one sample: Fe,P. (359 a, 568 c). White mine (see Marion furnace); L.; one sample: Fe,P. (359 b, 568 c).

TENNESSEE—Continued.

White county. Coal (bituminous), statistics of the production of, in c. y. (666–669).

Tertiary bog-ores in eastern counties of North Carolina (302 b); in Nash county, North Carolina (302 d).

TEXAS.

Iron. Amount in ore mined in the c. y. and its per cent. of total iron in the United States ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron ore mined in c. y. (19 f).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 f); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (26 a); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 b).

Iron ore. Statistics of the production of iron ore in c. y. (56–59, 64–69).

Marion county. Iron ore: Amount of each kind of iron ore mined in the c. y. (26 a); statistics of the production of iron ore in, in c. y. (56–59).

Tin, imports and exports of (830).

Titaniferous magnetite, Lower Laurentian, in Forsyth, Guilford, and Rockingham counties, N. C. (308 c); in New Jersey (147 a); in New York (106 f, 108 a); in the Rocky mountains (472 c).

Triassic blackband and ball-ore of Moore county (N. C.); hematite of Chatham and Moore counties (N. C.), (303 e, 305 a); limonites of Moore county (N. C.), (306 e).

Tuomey, M., description of the fossil ores of Cherokee county, Ala., by (383 d).

U.

UTAH.

Coal (bituminous), statistics of the production of, in c. y. (676–678).

Iron ores, partial analyses of (572–575).

Iron ores in Utah. Notes on the samples of iron ore collected in, by Bayard T. Putnam (486–496); magnetite in Iron county (486 d); map of the claims (487); mines near Frisco (490 a). Limonite in the East Tintic mountains (490 e); Iron ore near Ogden (491 f); hematite near Willard (492 b).

Beaver county. Iron-ore deposits: Bowen's mine (Wah-Wah mountains); M.; one sample: Fe,P. (489 f, 572 f). Cave mine; L.; one sample: FeP. (490 d, 572 f). Frisco Mining and Smelting Company's mine; M.; one sample: Fe,P. (490 d, 572 f). Lake Superior mine; M.; one sample: Fe,P. (490 b, 572 f). Money's mine; M.; one sample: Fe,P. (489 f, 572 f). Vulcan mine; L.; one sample: Fe,P. (490 a, 572 f). Wah-Wah Mountain mine (see Bowen's mine); H.; one sample: Fe,P. 489 e, 572 f). Vulcan mine; L.; one sample: Fe, P. (488 a, 572 f).

Box Elder county. Willard mine; H. (s); one sample: Fe,P. (492 b, 574 d).

Iron county. Coal (bituminous), statistics of the production of, in c. y. (676–678). Iron-ore deposits: Adelaide mine; H.; one sample: Fe,P. (488 d, 574 b). Black Magnetic mine; M.; one sample: Fe,P. (488 d, 574 b). Blowout Mountain mine; M.; two samples: Fe,P. (488 f, 574 b). Duncan mine; L.; one sample: Fe,P. (489 a, 572 b). Excelsior and Chesapeake mine; M.; one sample: Fe,P. (488 f, 574 b). Great Western mine; M.; one sample: Fe,P. (488 a, 574 b). Marshall mine; M.; one sample: Fe, P. (485 f, 574 a). Mountain Peak mine; M.; one sample: Fe,P. (488 e, 574 b). Oak Springs mine; M.; one sample: Fe,P. (488 e, 574 b). Southern Cross mine; M.; one sample: Fe,P. (488 c, 574 b). Wanderer mine; M.; one sample: Fe,P. (488 c, 574 b). War Eagle mine; M.; one sample: Fe,P. (488 a, 574 a).

Juab county. Iron-ore deposits: Dragon (southern extension of); H.; one sample: Fe,P. (491 f, 574 c).

San Pete county. Coal (bituminous), statistics of the production of, in c. y. (676–678).

Summit county. Coal (bituminous), statistics of the production of, in c. y. (676–678).

Utah county. Iron-ore deposits: Billing's mine; H.; one sample; Fe,P. (491 f, 574 c). Black Stallion mine; H.; one sample: Fe,P. (491 d, 574 c). Hematite mine; H.; one sample: Fe,P. (491 f, 574 c). Queen of the West mine; H.; one sample: Fe,P. (491 f, 574 c). Sailor Boy mine; H.; one sample: Fe,P. (491 f, 574 c).

Weber county. Iron-ore deposits: Cold Creek mine; H.; one sample: Fe,P. (492 b, 574 c). Vulcan mine; H.; one sample: Fe,P. (490 a, 574 c).

V.

Vanuxem, L. On the relations of the ore formation in Jefferson and Saint Lawrence counties, New York (142 b); on the ore deposits in Oneida county, New York, referred to (136 d).

Vermilion lake, Minnesota, production of iron mines, 1883–1884 (34 b). Report of a trip to, by Bailey Willis (457–466).

VERMONT.

Copper ore. Statistics of the production of, in c. y. (798–799).

Iron. Amount in ore mined in c. y., and its per cent. of total iron in the United States' iron-ore product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 f).

Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 f).; amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 b); amount of each kind of ore mined in each county in the c. y. (26 a); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 b); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 c).

Iron ore. Statistics of the production of iron ore in c. y. (60–63, 64–69); general average of these statistics (70–71).

Iron ore. Partial analyses of (574–575); complete analyses of (599).

Iron ore. Notes on the samples of iron ore collected in, by Edward R. Benton (80–82); iron-ore sample *map* of Vermont and part of New Hampshire (81).

Ocher. Statistics of the production of, in c. y. (844, 850, 851).

Scythe-stones. Statistics of the production of, in c. y (845, 852–853)

Soapstone. Statistics of the production of, in c. y. (845, 852–853).

Whetstone. Statistics of the production of, in c. y. (845, 852–853).

Addison county. Iron-ore mines: Leicester mine mentioned (80 e); L.; one sample: Fe,P,Mn (574 d). Monkton mine mentioned (80 c); L.; one sample: Fe,P,Mn (574 d).

Bennington county. Iron ore mines: Godfrey mine mentioned; L.; one sample: Fe,P. (81 a, 574 e).

Franklin county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 a); statistics of the production of iron ore in c. y. (60–63).

Orange county. Copper ore, statistics of the production of, in c. y. (798–799).

Orleans county. Whetstone, statistics of the production of, in c. y. (845).

Rutland county. Ocher, statistics of the production of, in c. y. (844). Iron-ore mines: Bethel or Pittsfield mine mentioned; M.; two samples: Fe,P. (82 d, 574 e). Brandon mine mentioned (80 d); L.; one sample: Fe,P,Mn (574 d). Chipman mine mentioned; L.; one sample: Fe,P. (81 f, 574 e). Forestdale or Blake mine mentioned; L. and H.; one sample: Fe,P,Mn (80 d; 574 d). Granger or Pittsford pit mentioned; L.; one sample: Fe,P. (80 f, 574 d).

Washington county. Scythe-stones, statistics of the production of, in, in c. y. (845).

Windsor county. Iron-ore deposits in (81 f). Iron-ore mine: Tyson furnace described; one sample: c. (82 a, 574 e, 599). Scythe-stones, statistics of the production of, in c. y. (845). Soapstone, statistics of the production of in c. y. (845).

Windham county. Soapstone, statistics of the production of, in c. y. (845).

VIRGINIA:

Coal (anthracite), statistics of the production of, in c. y. (625–630, 650–651).

Barytes, statistics of the production of, in c. y. (839, 846–847).

Coal (bituminous), statistics of the production of, in c. y. (670–673, 674–675).

Hydraulic cement, statistics of the production of, in c. y. (841, 848–849).

Iron. Amount in ore mined in c. y. and its per cent. of total iron in the United States' ore product (19 f); amount of iron in the different kinds and grades of ore mined in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 f).

Iron ore. Order of state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).

Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 f); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 c); amount of each kind of ore mined in each county in the c. y. (26 b); amount of each kind and grade of ore, according to its contents of iron, produced in c. y. (28 c); amount of each kind and grade of ore, according to its phosphorus-iron ratio, produced in, in c. y. (29 e, 30 c); royalty paid on each kind of ore mined in, in c. y. (32 c).

VIRGINIA—Continued.

Iron ore. Statistics of the production of, in c. y. (60–63, 64–69).

Iron ore. Bessemer, amount of each kind mined in c. y. (30 e); its per cent. of the Bessemer ore product of the United States (30 e).

Iron ores. Complete analyses of (599–601); partial analyses of (574–579).

Iron ores. Archæan iron ores, character of (6 f); hematite deposits in the Potsdam sandstone in (10 b); occurrence of the Clinton ores in (13 c); Oriskany ores in (15 a); character of the iron ore in the Devonian shales of (15 b); occurrence of nodular carbonates of iron in (15 c); impure iron ore in the Catskill formation in (15 c).

Iron ores. Notes on the samples of iron-ore collected in, by Edward R. Benton (261–288); Iron-ore sample *map* of Virginia (geologically colored) (Plate XXX); *map* of Virginia and West Virginia showing the area represented by Plate XXX (262); east of the Blue Ridge, Albemarle county (263 e); James River ore belt (264 a); southwestern Virginia, Cripple creek, and New River belt (273 f); James River basin (277); Purgatory and Mays mountain (278); Brushy mountain (279); Rich Patch mountain (281); Pott's creek (283); Warm Springs mountain, section along base of (284); Peters mountain (284); Shenandoah valley (286); Massanuttan mountain (287); North mountain (288); Great North mountain (288).

Lead and zinc ore, statistics of the production of, in c. y. (804–805, 806).

Manganese, statistics of the production of, in c. y. (842, 850–851).

Ocher, statistics of the production of, in c. y. (844, 850, 851).

Albemarle county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 a); statistics of the production of iron ore in, in c. y. (60–63). Iron-ore mines: North Garden mine; M. and L; one sample: Fe, P, Ti, Mn (263 e, 576 d).

Alleghany county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 a); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Clifton Forge mine; H.; one sample: Fe, P. (280 f, 578 b). Dickey mine; L.; one sample: Fe, P. (284 e, 578 c). Dolly Ann mines; Oriskany; described; section (284); L.; one sample: Fe, P. (284 a, 578 d). Gay and Lewis mine; L.; one sample: Fe, P. (284 f, 578 c). Given's (A) mine; L.; one sample: Fe, P. (283 d, 578 c). Huddleson mine; L.; one sample: Fe, P. (285 a, 578 c). Longdale mine; Oriskany; described; section (279 d, 280); L.; two samples: Fe, P.; one sample: c. (279 e, 578 b, 601). Lowmoor iron mines; Upper Silurian; described; sketch-map (281 e, 282); L.; two samples: c. (281 e, 578 c, 601). Sadler or Stack mine; L.; two samples: Fe, P. (285 d, 578 c). Smith-McAlister mine; L.; one sample: Fe, P. (284 d, 578 c). Trice mine; L.; one sample: Fe, P. (285 c, 578 c). Will's mine; L.; one sample: Fe, P. (284 d, 578 d).

Amherst county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Adams, Scott and Company's mine No. 11 (James river); Archæan (Huronian?); described; section (265 e). Adams, Scott and Co. (No. 10½) mine; H. (s); four samples: Fe, P. (265 d, 266 a, 574 f, 576 a). Brown hematite mine; L.; one sample: Fe, P. (265 c, 576 b). Dover Company's (No. 6) mine; H.; one sample: Fe, P. (267 e, 574 f). Dover Company's mine No. 11, near Riverville; Archæan (Huronian?); described; sections (266 b); H. (s); two samples: c. (266 b, 267 a, 574 f, 599). "First Vein" (east of Old Furnace vein); H. (s) with M.; one sample; Fe, P. (264 f, 576 b). Maud vein, Stampleton mine; Archæan (Huronian?); described; sections (268 b); H. (s); five samples: Fe, P. (268 b, 269 a, 574 f), Naylor and Co. (No. 6½) mine; H. (s); two samples: Fe, P. (267 f, 268 a, 574 f). "Second Vein" (east of "Old Furnace Vein"); M.; one sample: Fe, P. (265 b, 576 b). Slippery Gut mine; L.; one sample: Fe, P. (264 e, 576 b).

Appomattox county. Iron-ore mines: Chestnut Mountain mine; H. (s); one sample: Fe, P. (269 c, 578 e). Cross-cut (Archer's Creek) mine; H. and L.; five samples: Fe, P. (269 f, 270 a, 576 c) Red Belt mine; L.; one sample: Fe, P. (269 d, 576 c). Stonewall mine; L.; one sample: Fe, P. (269 b, 578 e).

Augusta county. Coal (anthracite), statistics of the production of, in c. y. (625–630). Iron ore: Amount of each kind of iron ore mined in, in c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Buffalo Gap mine; L.; one sample: Fe, P. (288 b, 578 d). Grace or Ferrol mine; L. and H.; two samples: Fe, P. (288 a, 578 d). Kennedy mine; L.; one sample: Fe, P. (286 a, 578 d). Mount Torrey or Virginia mine; L.; one sample: Fe, P. (286 b, 578 d). Manganese, statistics of the production of, in c. y. (842).

Bedford county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63).

Botetourt county. Coal (bituminous), statistics of the production of, in c. y. (670–673). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Arcadia iron mine; Lower Silurian; described; sections (278 a). Arcadia (iron property) mine; L.; one sample: Fe, P. (278 e, 576 f). Arcadia (property) mine; H.; two samples: Fe, P. (277 f, 278 a, 576 f). Callie mines (old and new bank); L.; two samples: Fe, P. (281 b, 578 b). Carnes mine; L.; one sample: Fe, P. (279 a, 578 a). Hickory Hollow, or Salisbury mine; L.; three samples: Fe, P. (279 b, 578 b). May's mine; L.; one sample: Fe, P. (279 a, 578 b). Retreat mine; L.; one sample: Fe, P. (278 f, 576 f). Spengler mine; L.; one sample: Fe, P. (279 a, 578 a). Wood's (property) mine: H.; one sample: Fe, P. (277 e, 576 f).

Campbell county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Archer's Creek mine; L. and H.; five samples: Fe, P. (269 f, 576 c). Otter River mine; L.; one sample: Fe, P. (270 c, 576 c). Oxford (near) mine; L.; one sample: Fe, P. (270 c, 576 c). Railroad mine; L.; one sample: Fe, P. (269 e, 576 c). Magnanese, statistics of the production of, in c. y. (842).

Chesterfield county. Coal (bituminous), statistics of the production of, in c. y. (670–673). Ocher, statistics of the production of, in c. y. (844).

Franklin county. Iron-ore mines: Rocky Mount mine; Archæan (Huronian?); described: sketch-map (271 f, 272); M.; one sample: Fe, P.; one sample: c (271 f, 273 a, 576 d, 559).

Louisa county. Iron ore: Amount of each kind of iron ore mined in, in c. y. (26 b); statistics of the production of iron ore in c. y. (60–63).

Montgomery county. Coal (bituminous), statistics of the production of, in c. y. (670–673).

Nelson county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mine: Greenway mine; H. (s); one sample: Fe, P. (264 a, 576 b).

Page county. Ocher, statistics of the production of, in c. y. (844).

Pittsylvania county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mine: Pittsville mine; Archæan (Huronian?); described; sketch-map (270 e, 271); M.; three samples: Fe, P. (270 e, 271 a, 576 c). Barytes, statistics of the production of, in c. y. (839).

Pulaski county. Coal (anthracite), statistics of the production of, in c. y. (625–630). Iron-ore mines: Johnson mine; L.; two samples: Fe, P. (275 f, 576 d f). Rich Hill mine; L.; one sample: Fe, P. (276 c, 576 f).

Rockingham county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore, in c. y. (60–63). Iron-ore mines: Fox Mountain (Shenandoah Iron Works) mine; L.; four samples: Fe, P. (287 a, 578 d). Miller mine; L.; one sample: Fe, P. (286 c, 578 d). Raines and Weaver mine; L.; one sample: Fe, P. (286 d, 578 e). Raines mine; L.; one sample: Fe, P. (286 f, 578 e). Ocher, statistics of the production of, in c. y. (844).

Rockbridge county. Hydraulic cement, statistics of the production of, in c. y. (841).

Shenandoah county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore, in c. y. (60–63). Iron-ore mines: Hollow Bank (Liberty furnace) mine; L.; one sample: Fe, P. (288 e, 578 e). Old Bank (Liberty furnace) mine; L.; one sample: Fe, P. (288 d, 578 e). Three-Top Mountain mine; L.; one sample: Fe, P. (287 e, 578 e). West Bank (Van Buren furnace); L.; one sample: Fe, P. (288 f, 578 e). Manganese, statistics of the production of, in c y. (842).

Smyth county. Iron-ore mines: Panic or White Rock mine; L. and H.; one sample: Fe, P.; one sample: c. (276 d, 576 f, 600).

Wythe county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Character of the limonite deposits in (11 b); origin of the limonite deposits in (11 b). Iron-ore mines: Carter mine; L.; one sample: Fe, P. (275 a, 576 d). Chadwell Farm mine; L.; two samples: Fe, P. (274 e, 576 c). Glade mine; L.; one sample: Fe, P. (277 a, 576 c). Hurst mine; Lower Silurian; described; section showing formation of limonite in limestone (275 b). Hurst mine; L.; one sample: Fe, P. (275 b, 576 d). Johnson mine; L.; one sample: c. (275 f, 576 d, 600). Noble mine; L.; one sample: Fe, P. (274 f, 576 f). Ravenscliffe mine; L.; two samples: c. (273 f, 274 a, 576 c, 600). Sampson's (Cripple Creek) mine; L.; two samples: Fe, P. (274 d, 576 e). Sayers and Oglesby mine; L.; two samples: Fe, P. (274 c, 576 e). Semi-Magnetic mine; H. and M.; one sample: Fe, P. (277 b, 576 d). Speedwell mine; L.; one sample: Fe, P. (273 e, 576 c). Walton mine; L.; one sample: Fe, P. (274 f, 576 e). Lead and zinc ore, statistics of the production of, in c. y. (804, 805–806).

W.

WASHINGTON TERRITORY.

Report on the coal-fields of, by Bailey Willis (759–771).

Coal-fields: general geology of (759); thickness of strata (757 d); section of Puget Sound basin (757 c); Coal Measures near head of Yakima river

WASHINGTON TERRITORY—Continued.
Coal-fields, etc.—Continued.
(761 b); section of, and comparison with Coal Measures west of Cascade range (761 c); analyses of representative samples of coals and lignites (761 d, 762 a); general character of coals and lignites (762 d); influence of intrusive dikes on (763 d); influence of flexures on (763 e); Wilkeson coal-field (763 f); Green River coal-field (767 a); detailed cross-sections of coal-beds of Wilkeson and Green River coal-fields (768 b); analyses of commercial samples from coal-fields of (769–771); analyses of coals and lignites of (772–781, 788–789); elementary composition of coals (790).
Green River coal-field: its position and boundaries (767 a); topography (767 c); geology (767 d); character of coal (768 b); detailed cross-section of (768 b); analyses of commercial samples of coal (769–771); analyses of coals and lignites (772–779); elementary composition of (790).
Wilkeson coal-field: its position and boundaries (763 f); topography (764 b); structural geology (765 d); Busy Brook section (766 d); character of coal (766 e); detailed cross-section of (768 b); analyses of commercial samples of coal (769–771); analyses of coals and lignites (772–779); elementary composition of coals (790).
Iron ores (497 c); partial analyses of (578–579).
Jefferson county. Iron-ore mines: Puget Sound Iron Company's mine; bog; two samples: Fe,P,S,Si,H_2O (497 e, 498 a, 578 f).
WEST of the 100th meridian. Iron ore: Notes on the samples of iron ore collected by Bayard T. Putnam (469); *map* showing deposits of iron ore west of the 100th meridian sampled (468); sketch of the blast-furnaces of the region (469–472); iron ores of Colorado; *map* of a portion of Colorado showing position of iron-ore deposits sampled (473); magnetite in Archæan (472); magnetite in Carboniferous (?) limestones (477); hematite (480); limonite (482); carbonate ore and its derivatives (484); iron ore in Wyoming; magnetite on the Chugwater (485); hematite at Rawlins (485 f); carbonate at Evanston (486 b); iron ore in Dakota (486 b); iron ores in Utah; limonite in the East Tintic mountains (490 e); hematite near Willard (492 b); iron ore in Montana and Idaho (492 d); iron ore in Nevada (492 e); iron ore in California (493 b); iron ore in Washington territory (497 c); iron ore in British Columbia (498 c); iron ore in Arizona (499 c); iron ore in New Mexico (499 e).
WEST VIRGINIA.
Coal (bituminous), statistics of the production of, in c. y. (670–673, 674–675).
Hydraulic cement, statistics of the production of, in c. y. (841, 848–849).
Iron ore. Amount in ore mined in c. y. and its per cent. of total iron in the United States' ore-product (19 f); amount of iron in the different kinds and grades of ore mined in, in the c. y. (28 f); average per cent. of iron in ore mined in c. y. (19 f).
Iron ore. Order of the state according to amount of iron in ore mined in c. y.; to average per cent. of iron in ore; to average spot value of ore; to total value of ore (19 f); to total amount of ore (74 e).
Iron ore. Amount and value of the c. y.'s product and their per cent. of the amount and value of the United States' product (19 f, 74 e); average value per ton (19 f); amount of each kind of ore mined in each geological horizon in the c. y. (21 b); amount of each kind of ore mined in the c. y. (23 c); amount of each kind of ore mined in each county in the c. y. (26 c); amount of each kind and grade of ore, according to its contents of iron, produced in, in c. y. (28 c); amount of each kind and grade of ore, according to its phosphorus iron ratio, produced in, in c. y. (29 e, 30 c); royalty paid on each kind of ore mined in c. y. (32 c).
Iron ore. Statistics of the production of, in c. y. (60–63, 64–69); general averages of these statistics (70–71).
Iron ore. Occurrence of the Clinton ores in (13 c); character of blackband ore in (16 a).
Iron ores. Partial analyses of (578–581).
Barbour county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Boone county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Braxton county. Coal (bituminous), statistics of the production of, in c. y. (670–673) Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 c); statistics of the production of iron ore in c. y. (60–63).
Brooke county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Doddridge county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Fayette county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Gilmer county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
WEST VIRGINIA—Continued.
Grant county. Coal (bituminous), statistics of the production of, in c. y. (670–673). Iron-ore mines: Lewis mine; F.; one sample: Fe,P. (580 c). Michael's mine; F.; one sample: Fe,P. (580 c).
Hampshire county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 b); statistics of the production of iron ore in c. y. (60–63). Iron-ore mines: Bloomary Furnace mine; L. and F.; three samples: Fe,P. (580 b).
Hancock county. Coal (bituminous), statistics of the production of, in c. y (670–673).
Hardy county. Iron ore: Amount of each kind of ore mined in, in the c. y. (26 c); statistics of the production of iron ore in c. y. (60–63). Iron-ore mine: Half Moon mine; L.; one sample: Fe,P. (580 c).
Harrison county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Jefferson county. Hydraulic cement, statistics of the production of, in c. y. (841).
Kanawha county. Coal (bituminous), statistics of the production of, in c. y (670–673). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 c); statistics of the production of iron ore in c. y. (60–63).
Lewis county. Coal (bituminous), statistics of the production of, in c. y (670–673).
Marion county. Coal (bituminous), statistics of the production of, in c. y (670–673).
Marshall county. Coal (bituminous), statistics of the production of, in c. y (670–673).
Mason county. Coal (bituminous), statistics of the production of, in c. y (670–673).
Mineral county. Coal (bituminous), statistics of the production of, in c. y (670–673). Iron-ore mines: Martin's mine; L.; one sample: Fe,P. (580 b). Olcar mine; H.; one sample: Fe,P. (580 b).
Monongalia county. Coal (bituminous), statistics of the production of, in c. y. (670–673). Iron-ore mines: Cole's Run mine; C.; one sample: Fe,P. (578 f, 580 b). Hope mine; C.; one sample: Fe,P. (580 a). Ice's Ferry mine; C.; one sample: Fe,P. (580 b). Johnson's mine; C.; two samples: Fe,P. (578 f). Spring Hill or Wadsworth mine; C.; one sample: Fe,P. (578 f).
Morgan county. Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 c); statistics of the production of, in c. y. (60–63).
Ohio county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Pleasant county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Preston county. Coal (bituminous), statistics of the production of, in c. y. (670–673). Iron ore: Amount of each kind of iron ore mined in, in the c. y. (26 c); statistics of the production of iron ore, in c. y. (60–63).
Putnam county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Randolph county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Ritchie county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
Roane county. Coal (bituminous), statistics of the production of, in c. y. (670–673).
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